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EDITED BY
WILLIAM CROOKES, F.R.S., &c.

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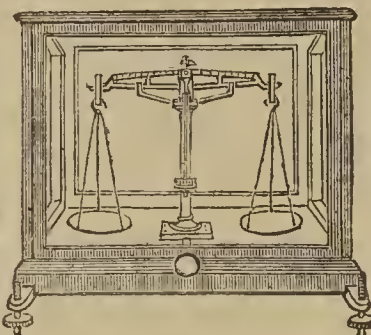
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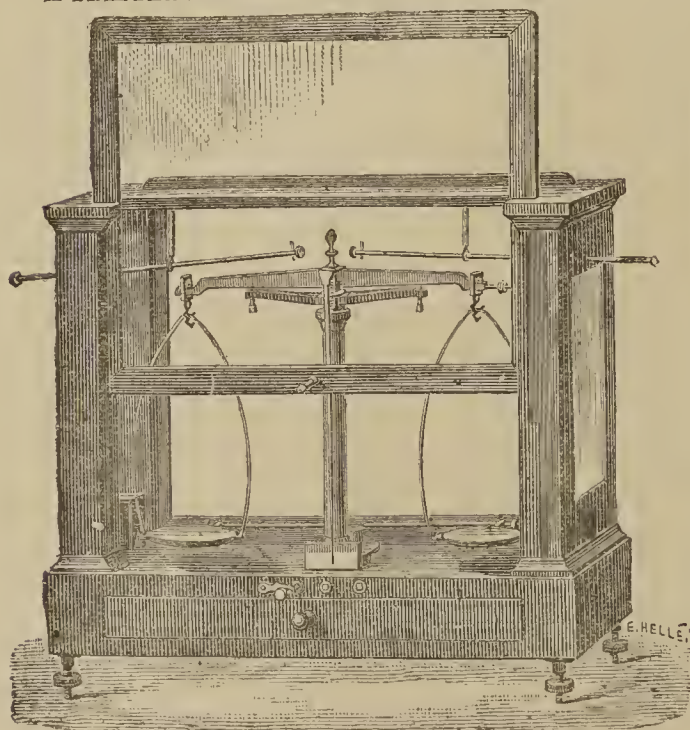
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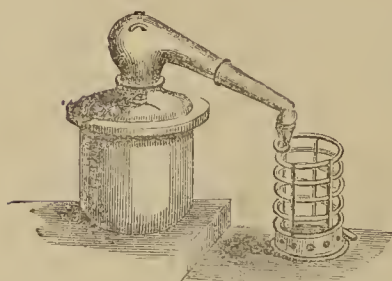
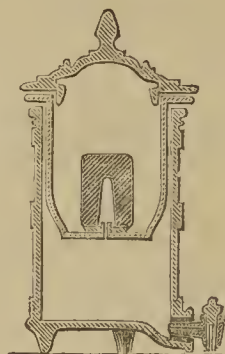
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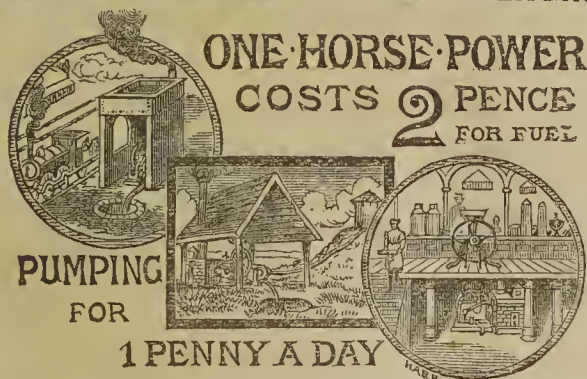
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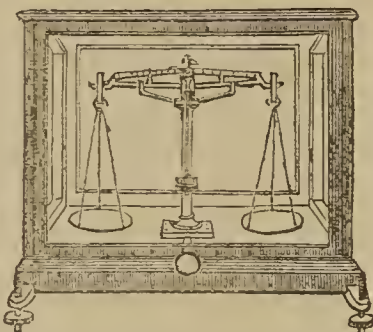
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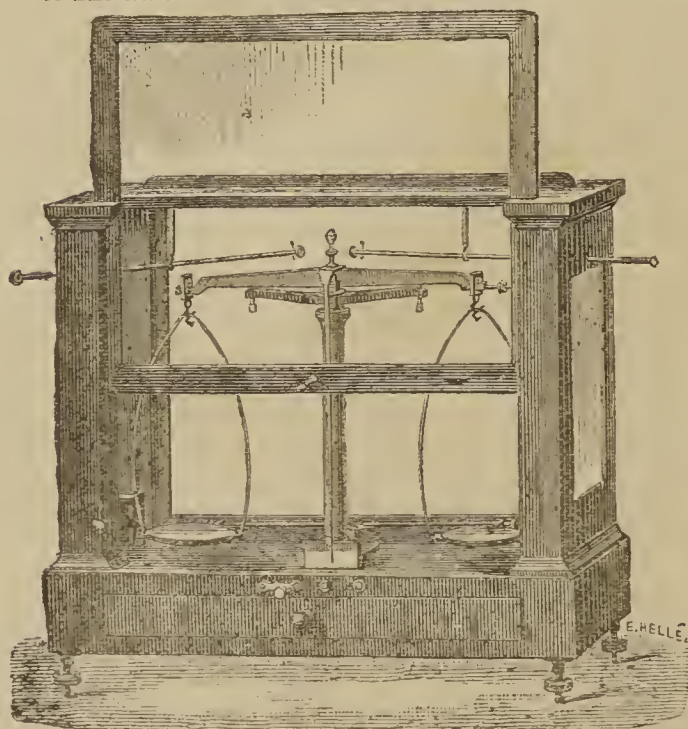
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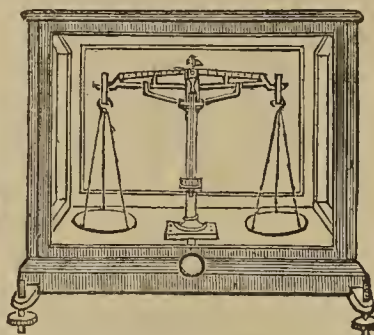
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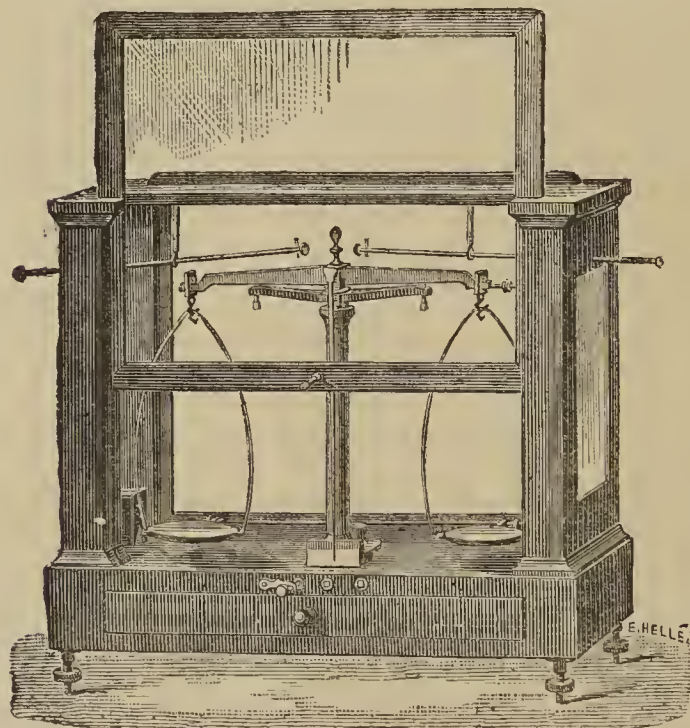
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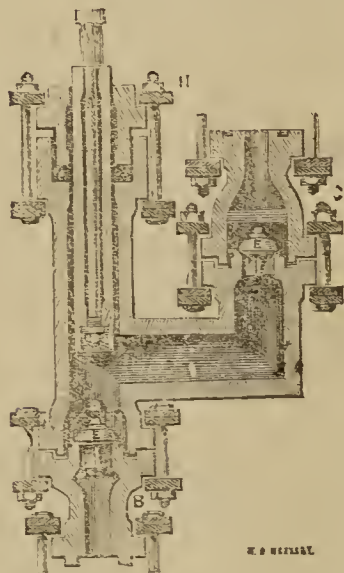
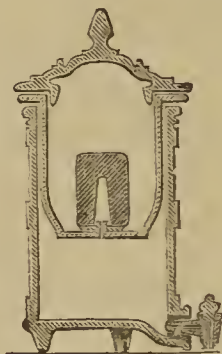
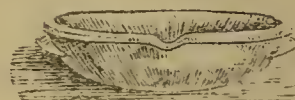
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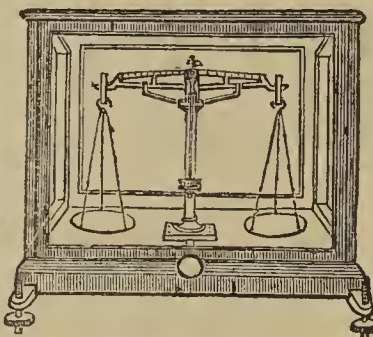
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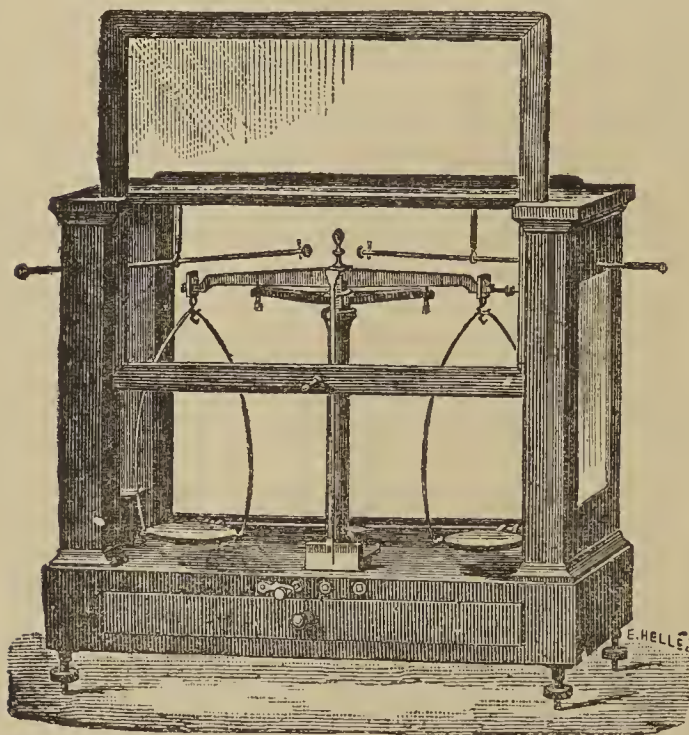
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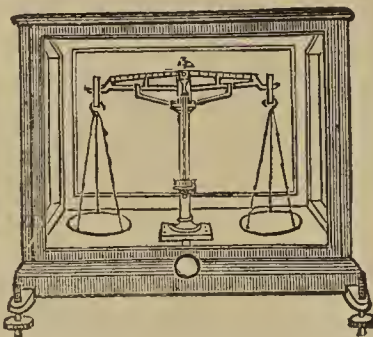
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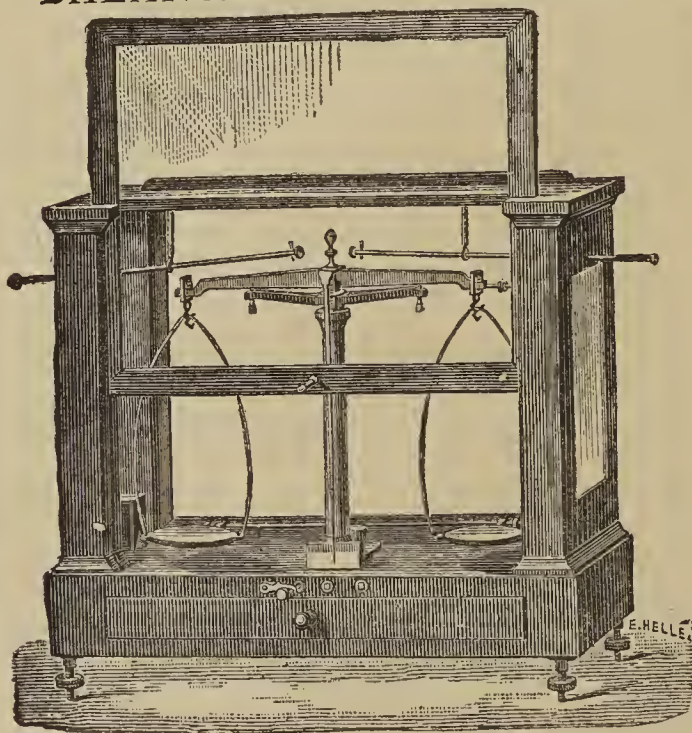
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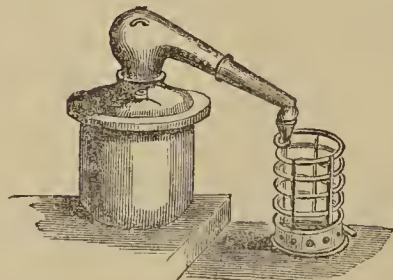
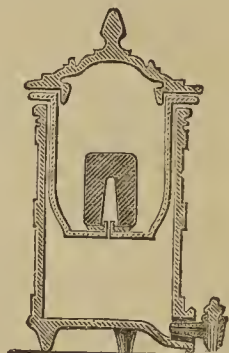
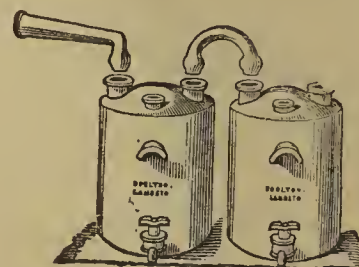
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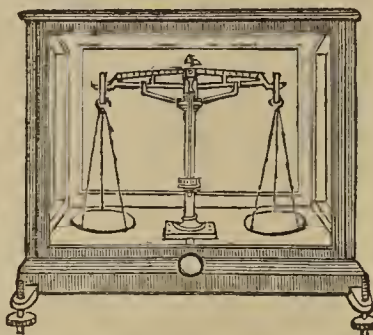
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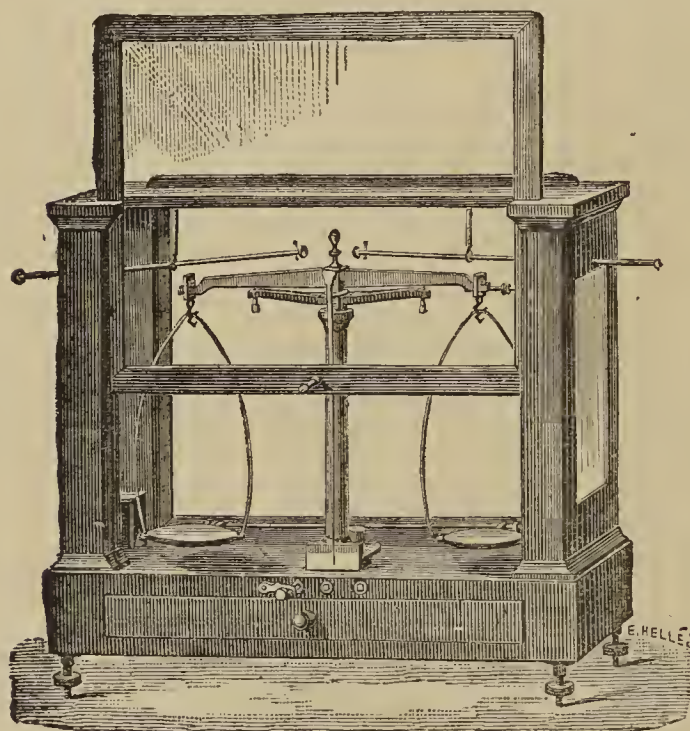
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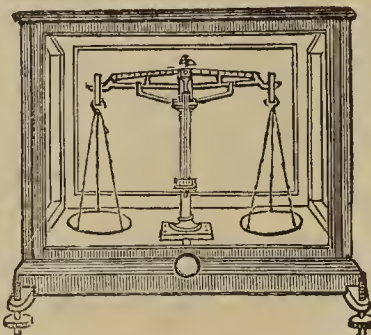
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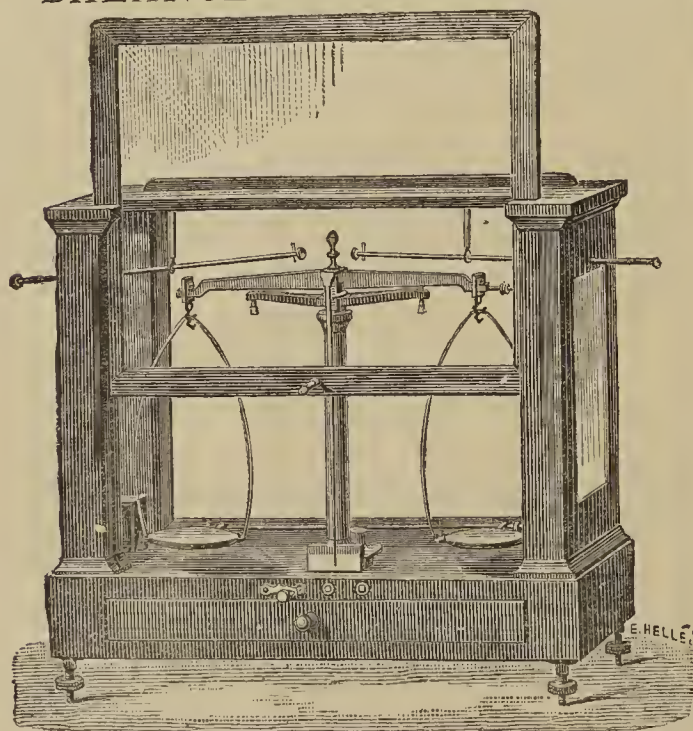
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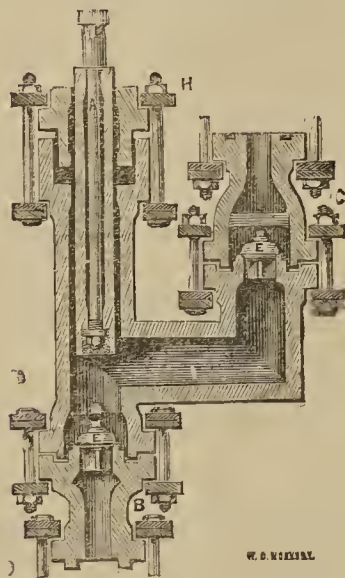
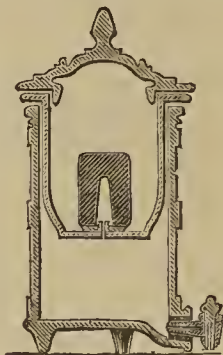
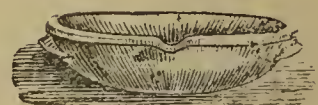
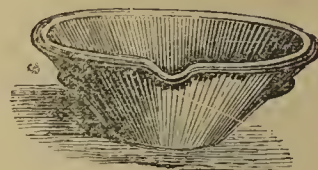
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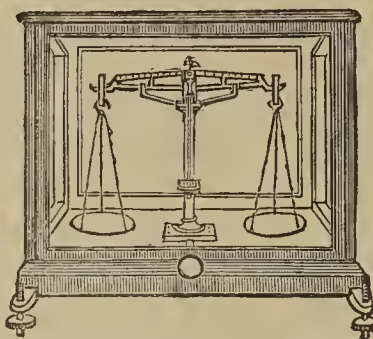
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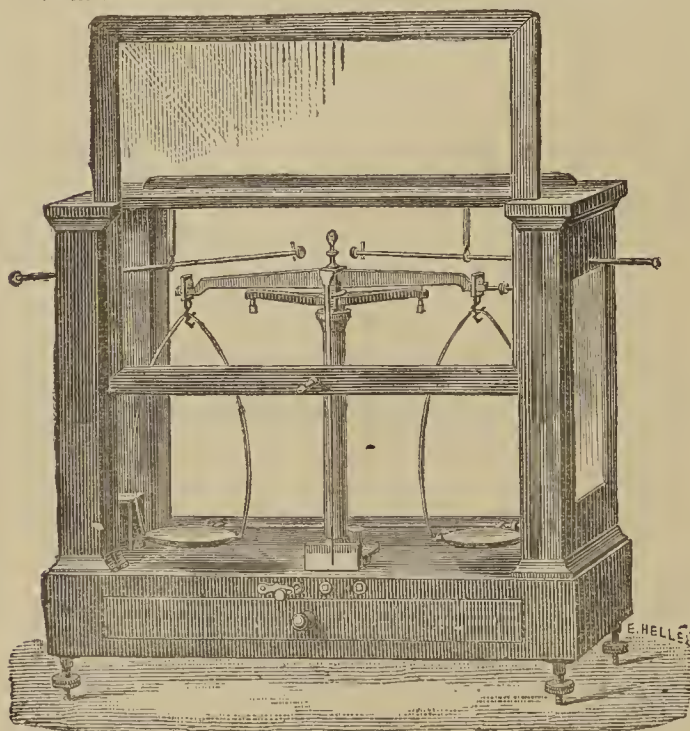
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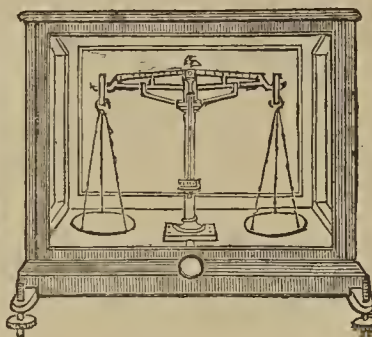
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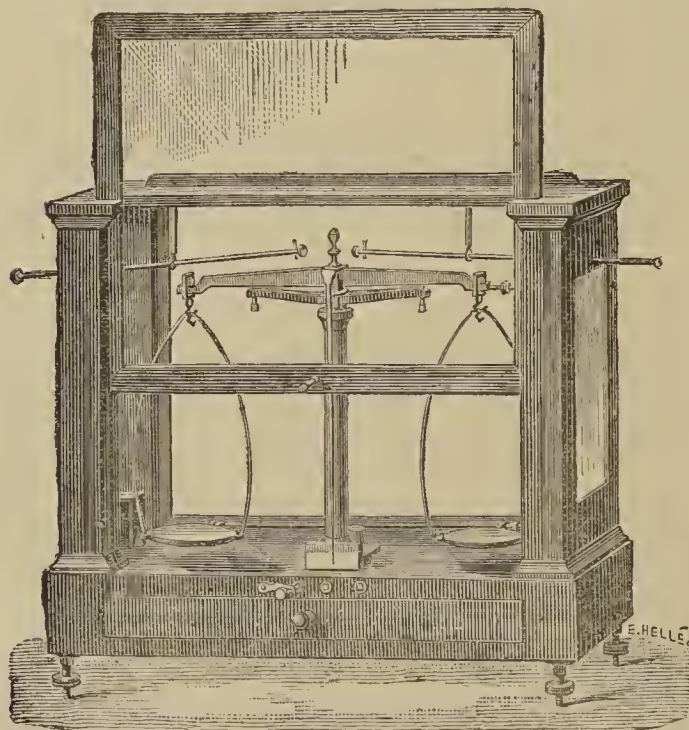
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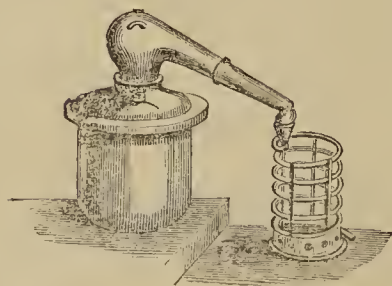
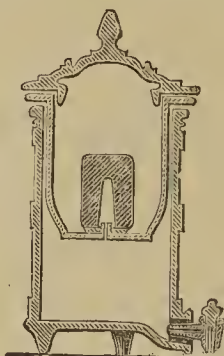
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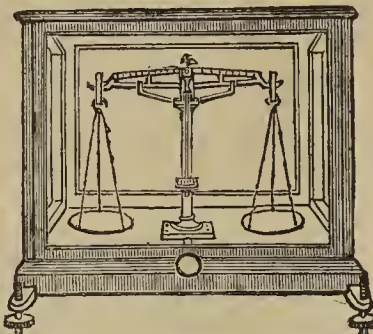
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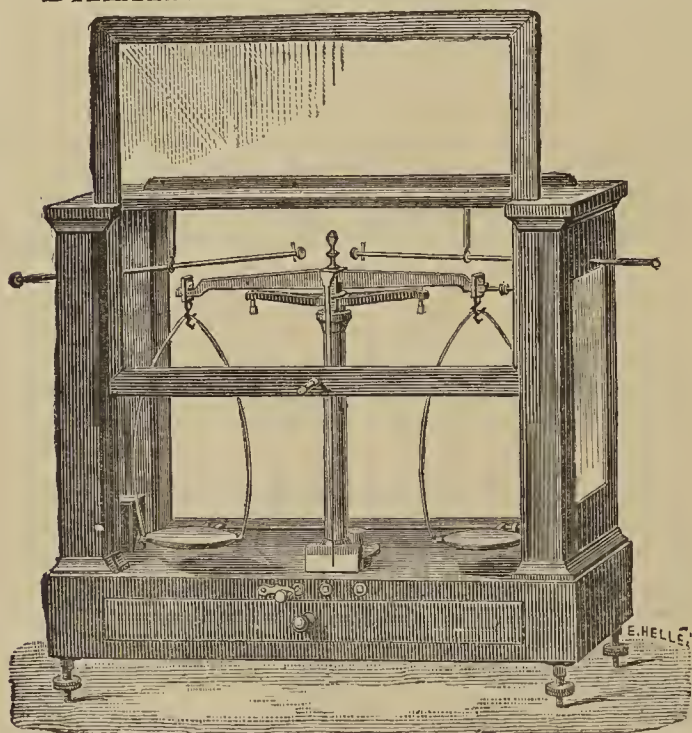
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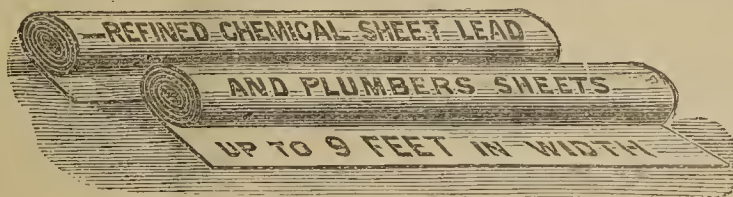
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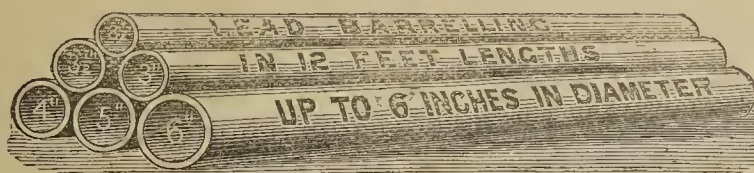
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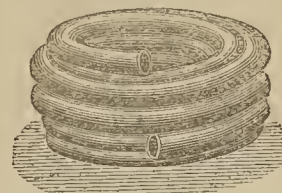


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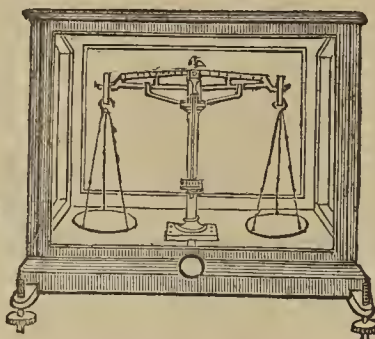
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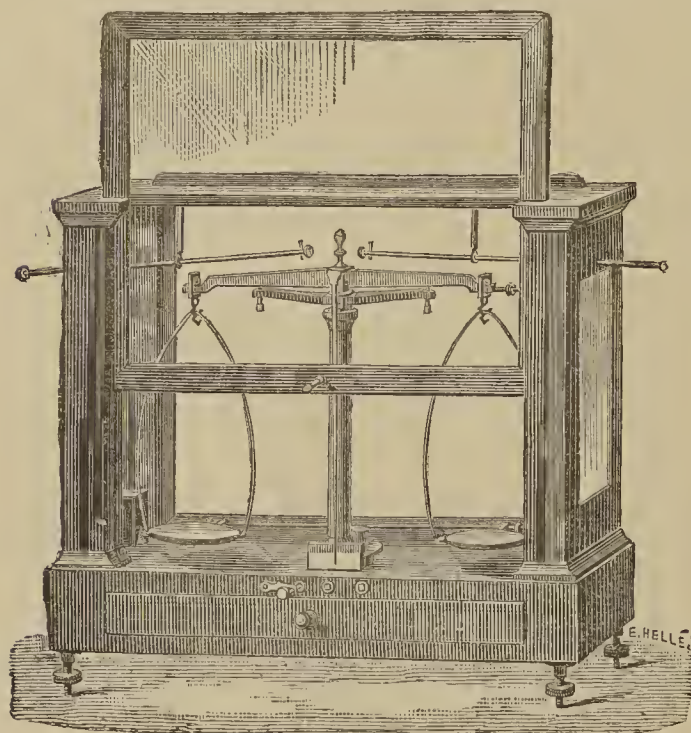
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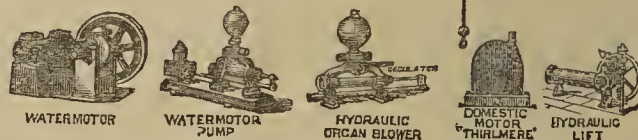
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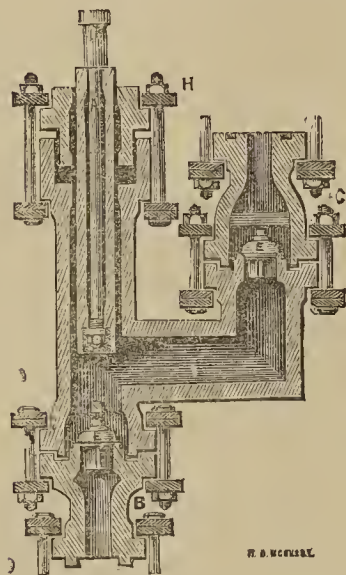
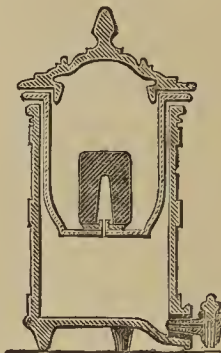
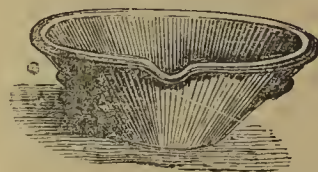
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Carbonate of Potash	95.50	81.87
Sulphate of Potash	0.58	0.08
Chloride of Potassium	0.94	0.20
Phosphate of Potash	—	trace
Carbonate of Soda	1.31	1.35
Silica, Alumina, &c.	0.18	0.06
Insoluble... ..	0.37	none
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THE LONDON HOSPITAL and MEDICAL COLLEGE, MILE END, E.—The SESSION 1883-4 will commence on Monday, October 1st, 1883. The Prizes for the past Session, and the Nursing Probationers' Prizes, will be distributed on Tuesday, October 9th, at 8 p.m., by Professor Huxley, P.R.S., who will also make an Address, after which there will be a Conversation, to which all past and present students are invited. **FOUR ENTRANCE SCHOLARSHIPS**, value £60, £40, £30, and £20, will be offered for competition at the end of September to new Students. Fees for Lectures and Hospital Practice, 90 guineas in one payment, or 100 guineas in three instalments. All resident and other Hospital appointments are free. The resident appointments consist of Five House Physiciancies, Five House Surgeoncies, and One Accoucheurship; Two Dressers and Two Maternity Pupils also reside in the Hospital. Special entries may be made for Medical and Surgical Practice. The London Hospital is now in direct communication by rail and tram with all parts of the metropolis.

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PHYSICS—Professor Guthrie will begin a course of lectures on 3rd October.

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Further particulars may be obtained from the Registrar.

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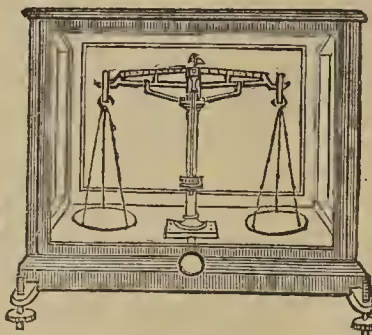
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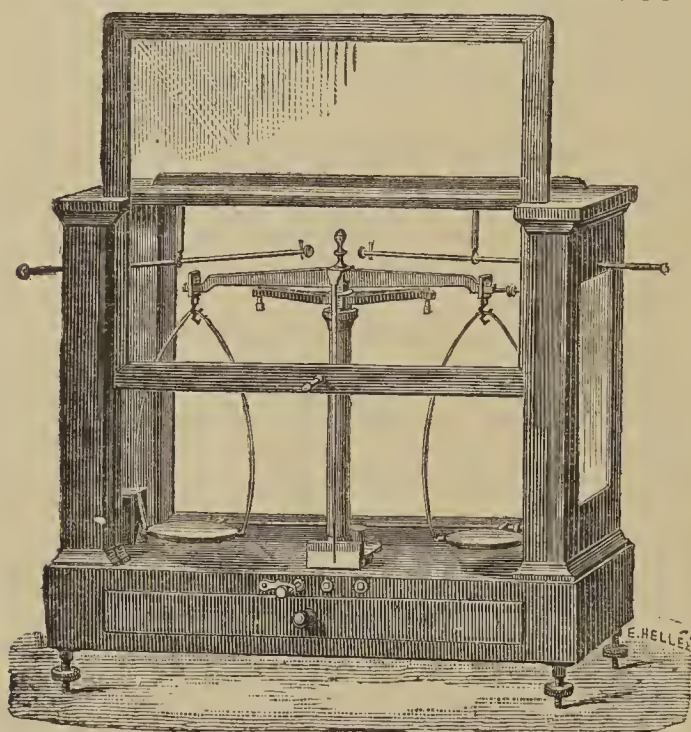
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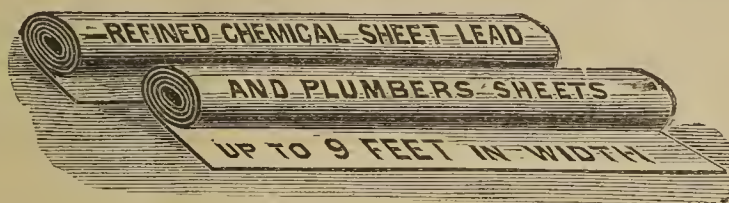
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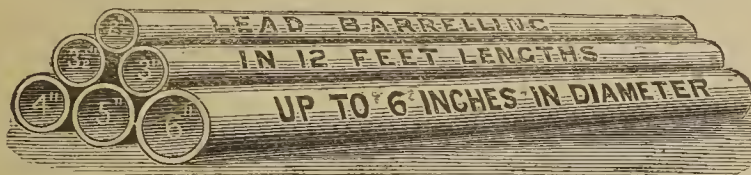
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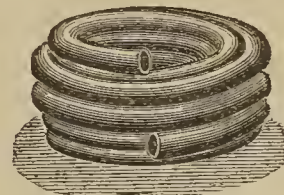


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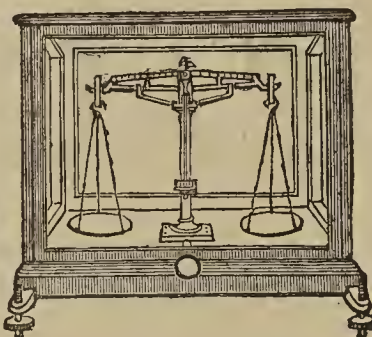
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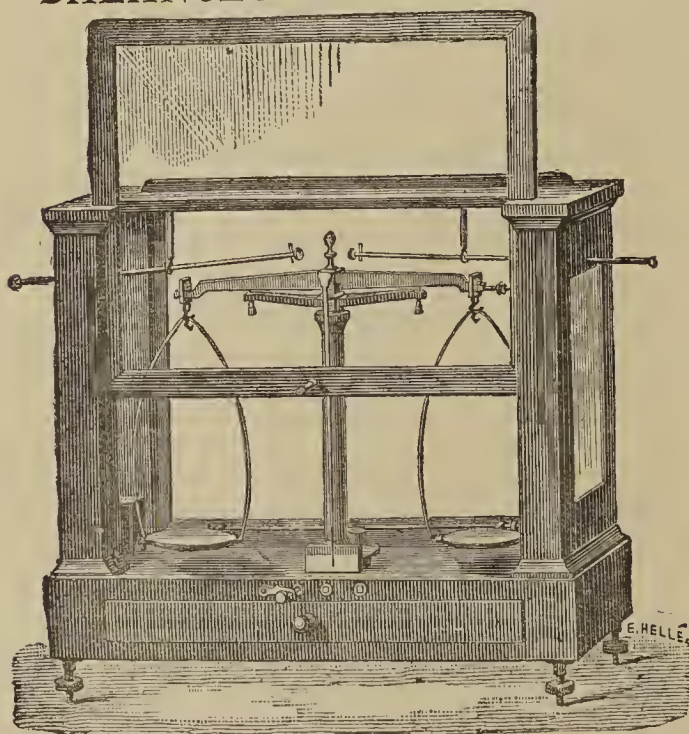
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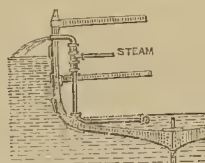
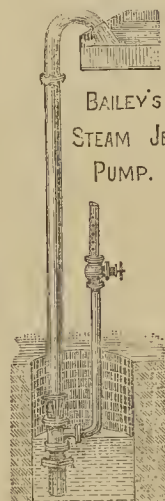
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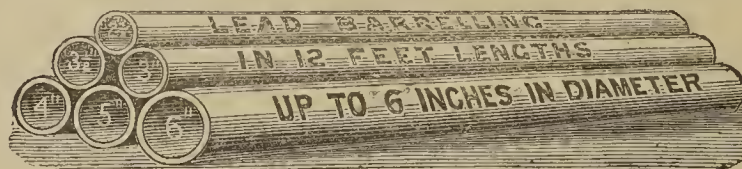
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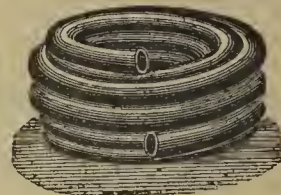
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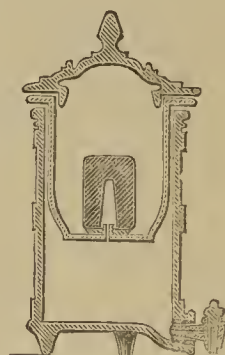
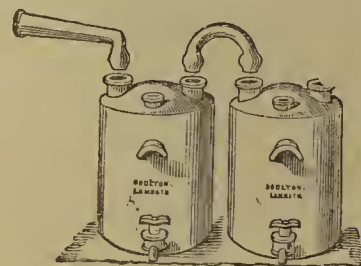
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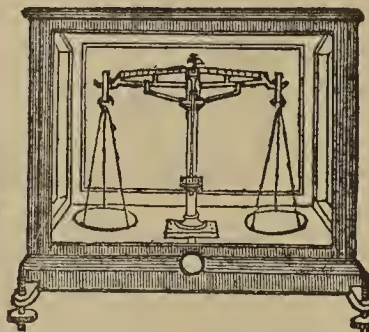
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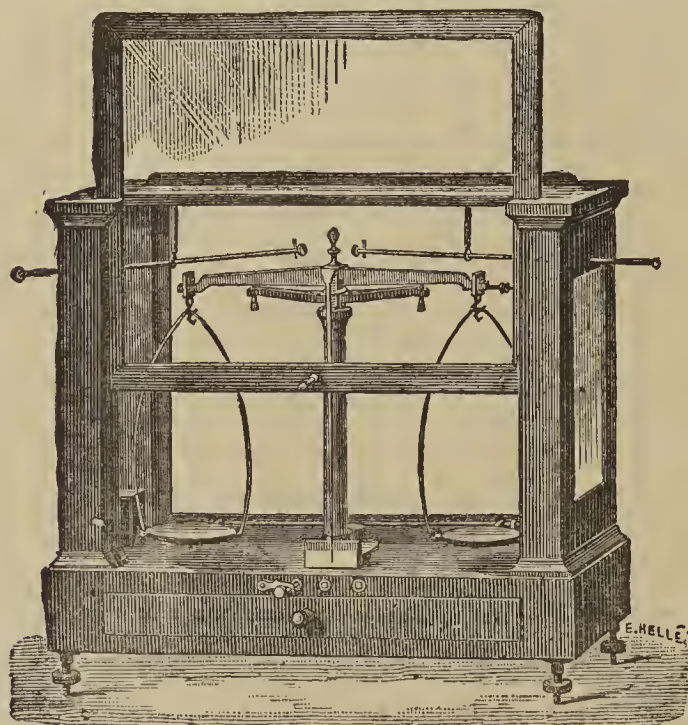
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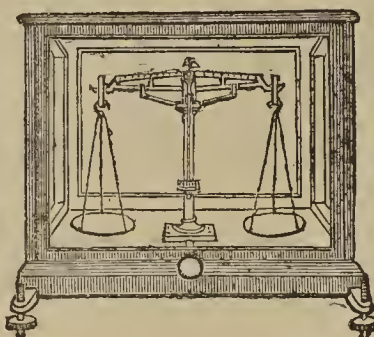
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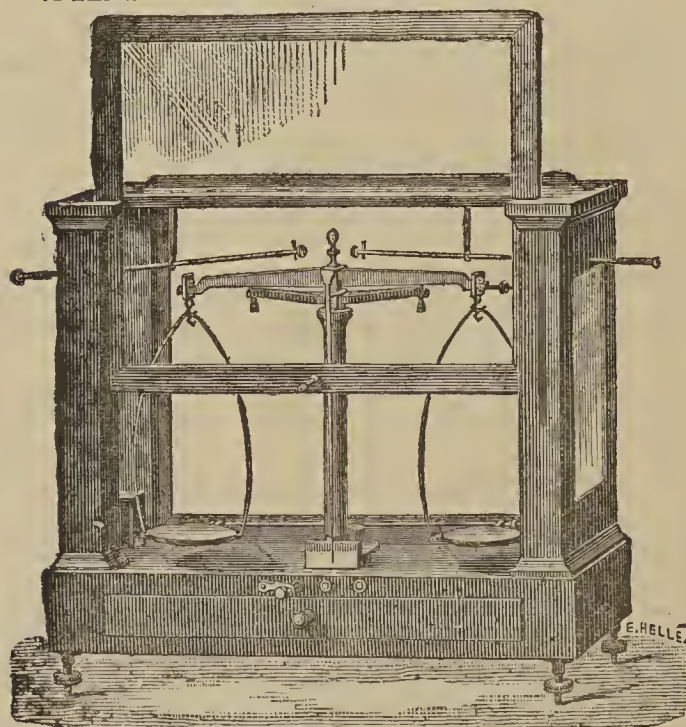
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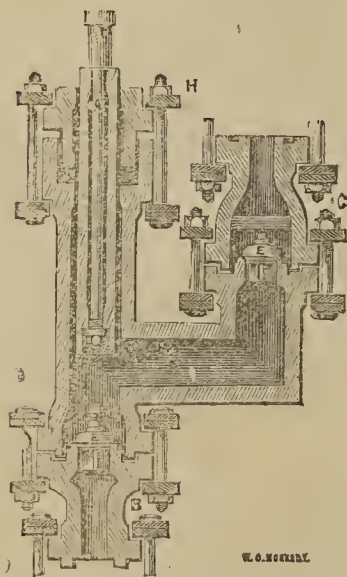
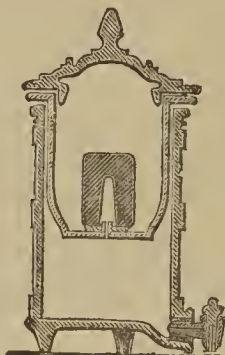
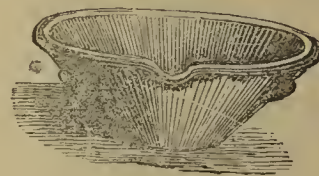
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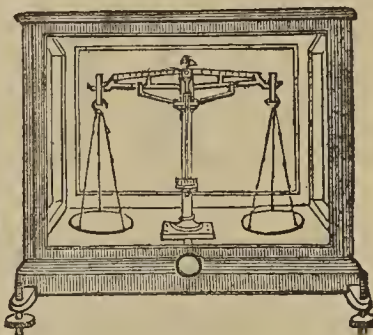
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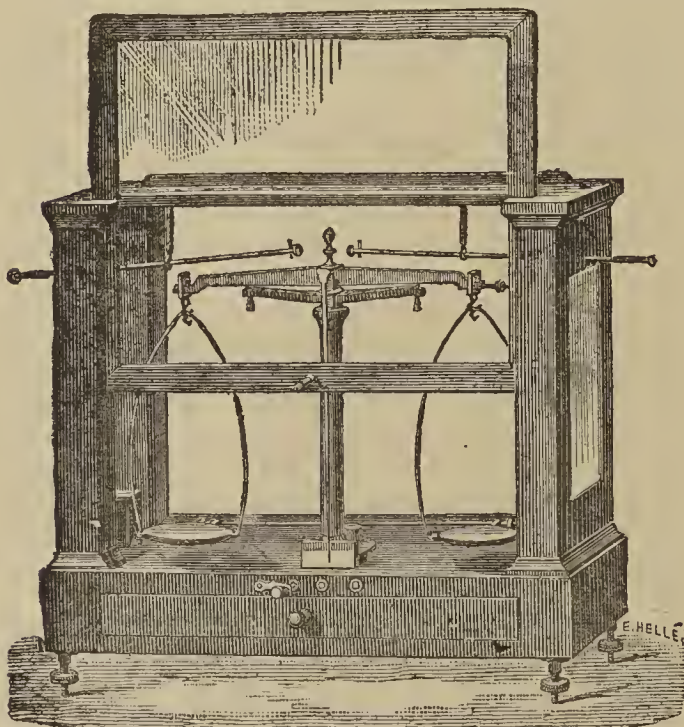
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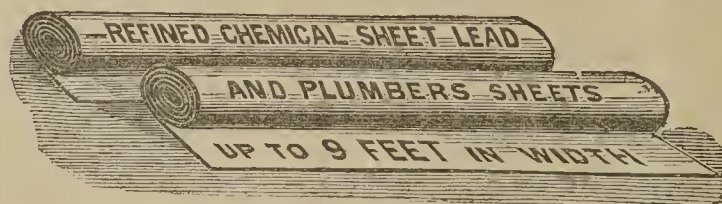
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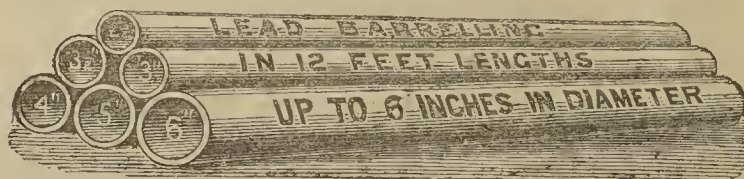
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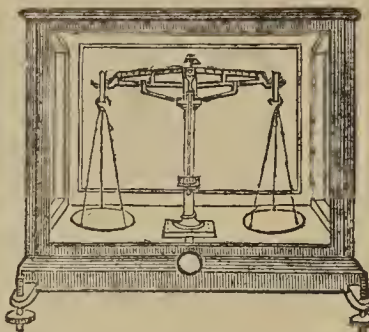
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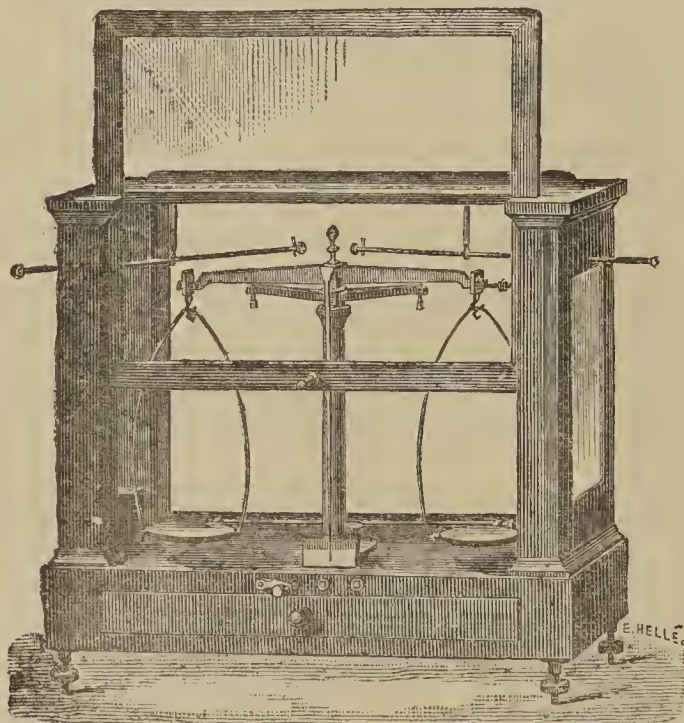
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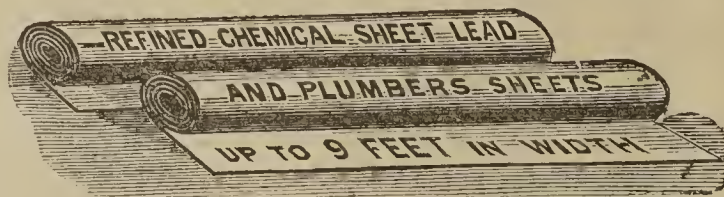
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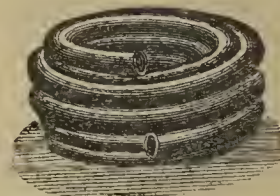
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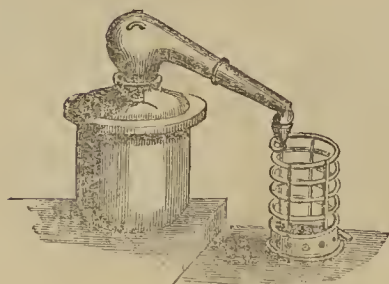
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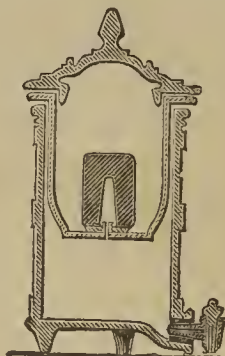
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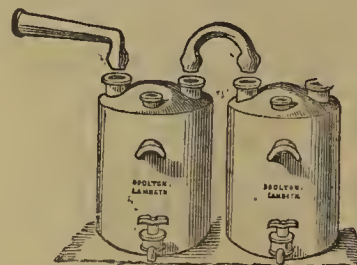
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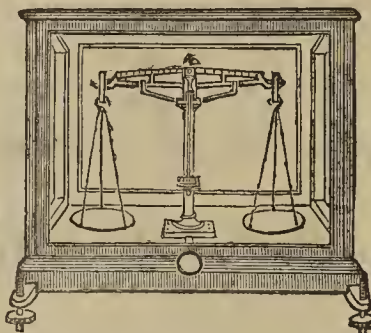
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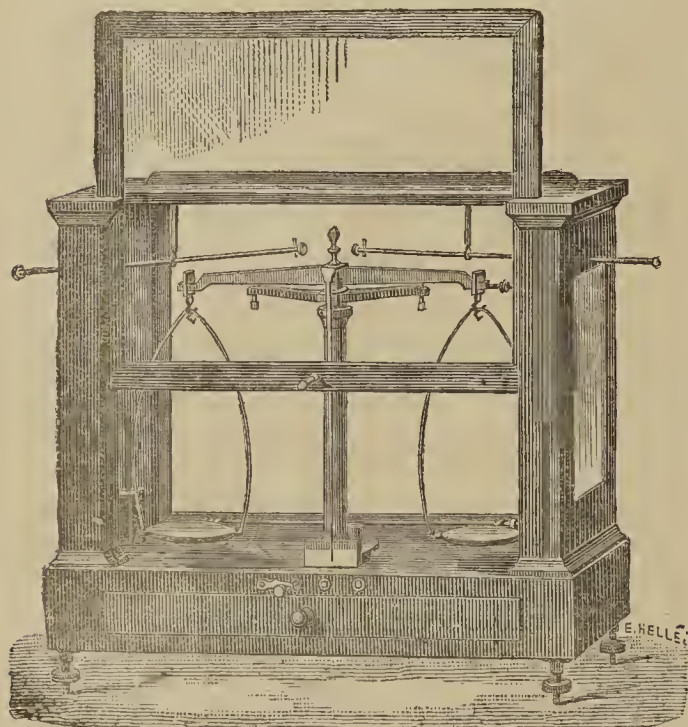
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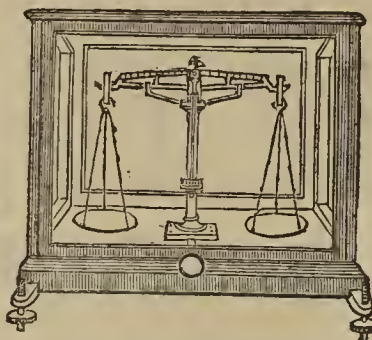
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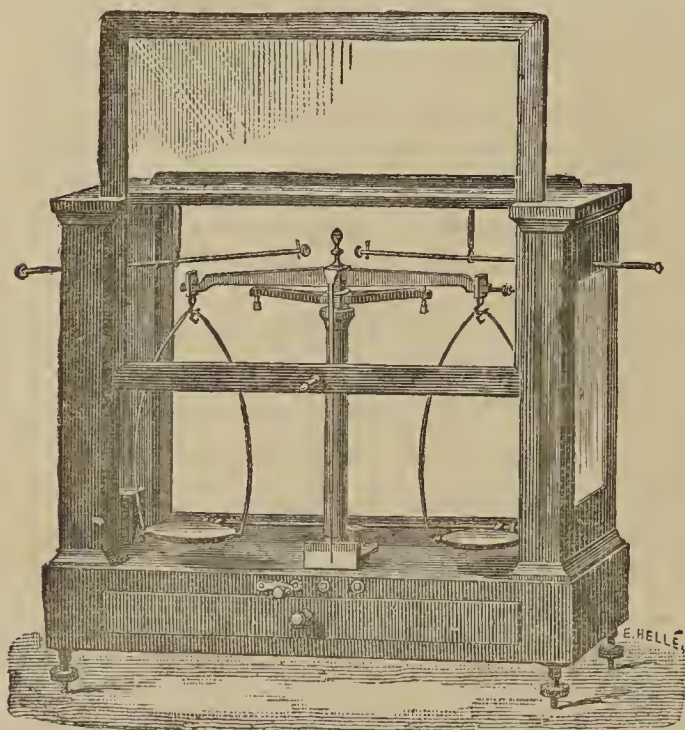
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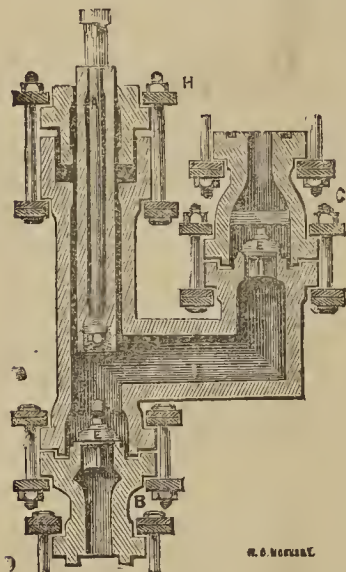
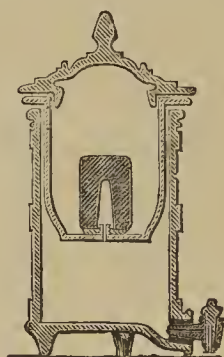
	CALCINED.	HYDRATED.
Carbonate of Potash	95.50	81.87
Sulphate of Potash	0.58	0.08
Chloride of Potassium	0.94	0.20
Phosphate of Potash	—	trace
Carbonate of Soda	1.31	1.35
Silica, Alumina, &c.	0.18	0.06
Insoluble... ..	0.37	none
Water	0.92	16.30
	99.80	99.86
Potash	66.00	55.81

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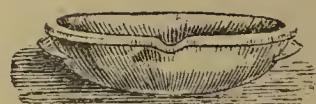
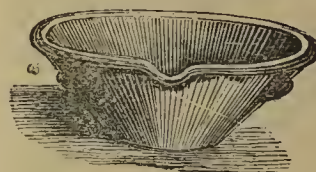
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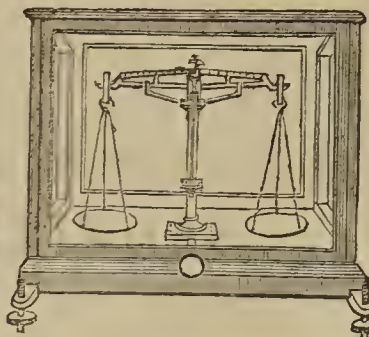
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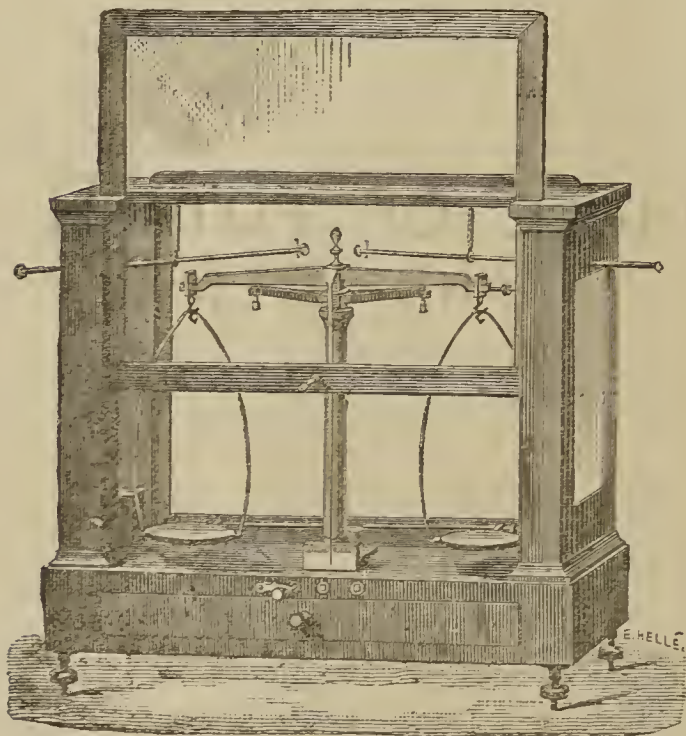
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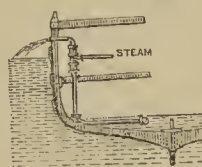
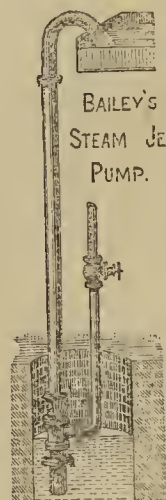
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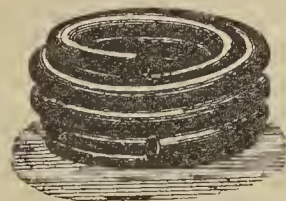
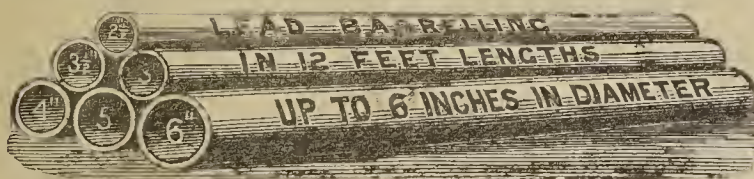


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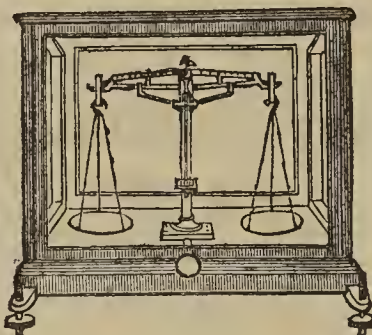
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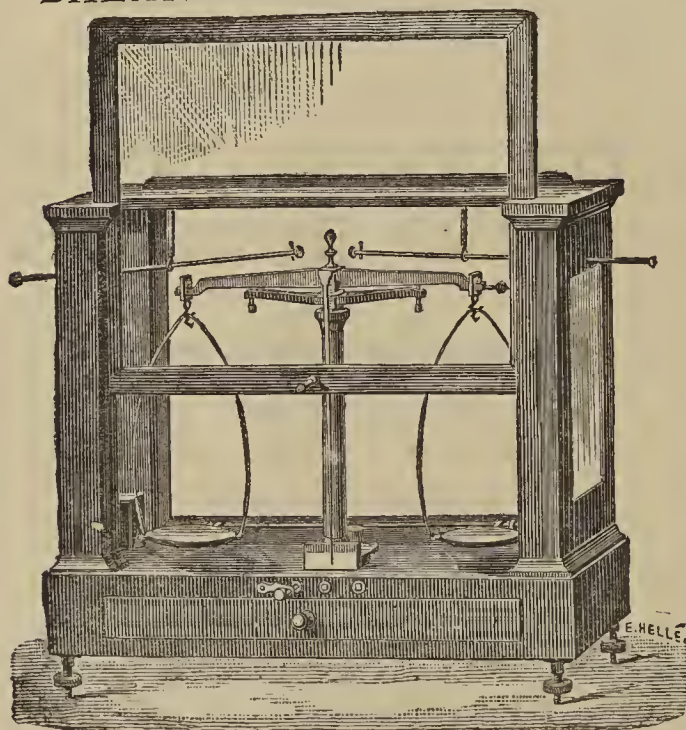
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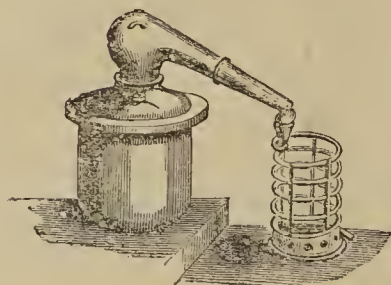
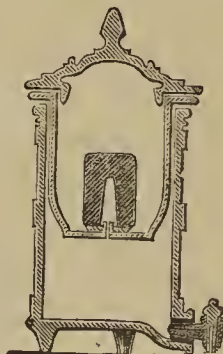
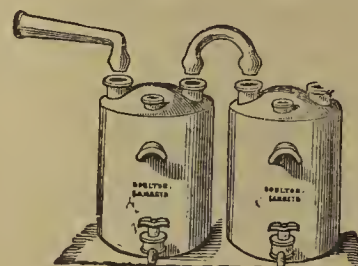
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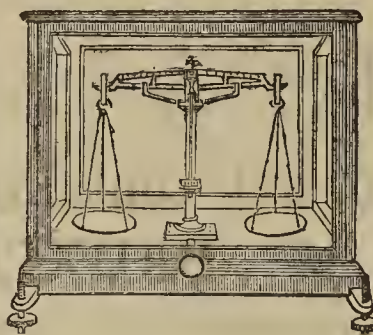
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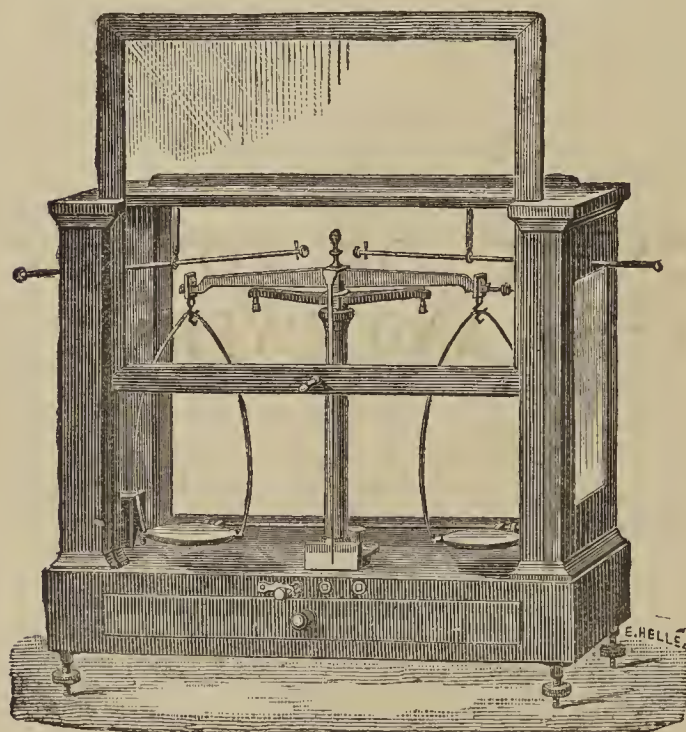
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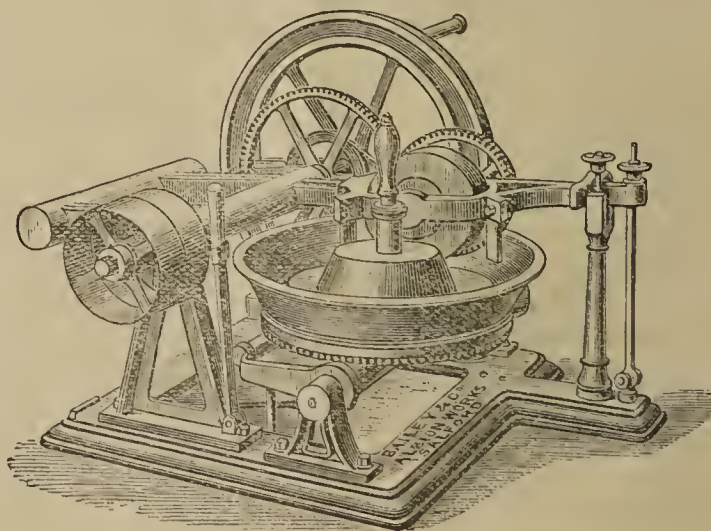
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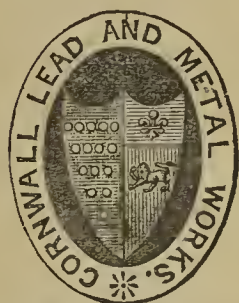
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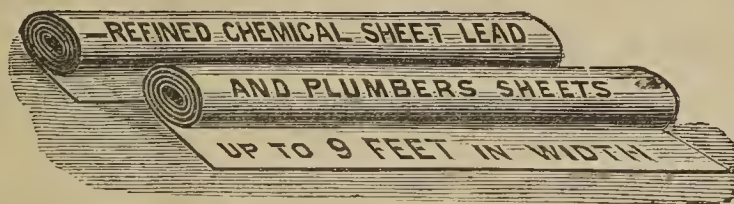
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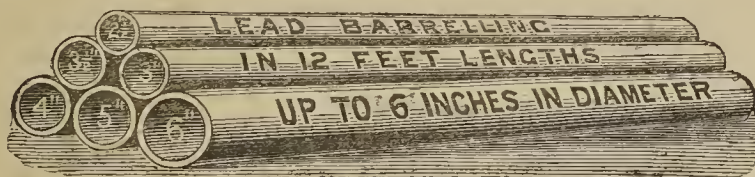
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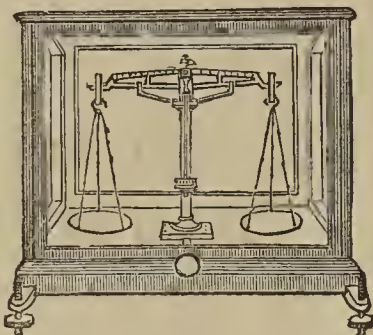
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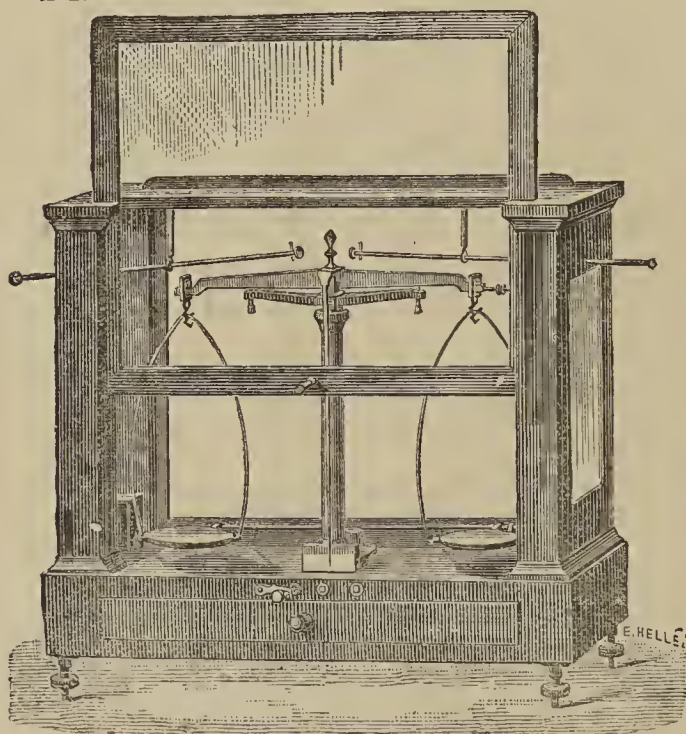
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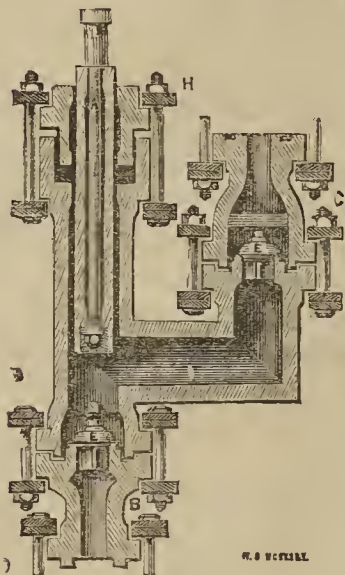
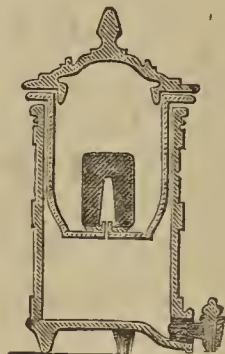
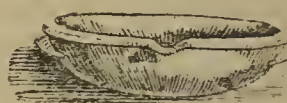
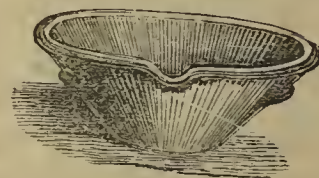
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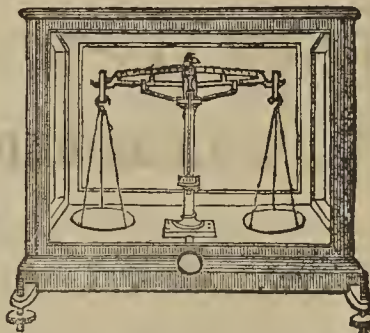
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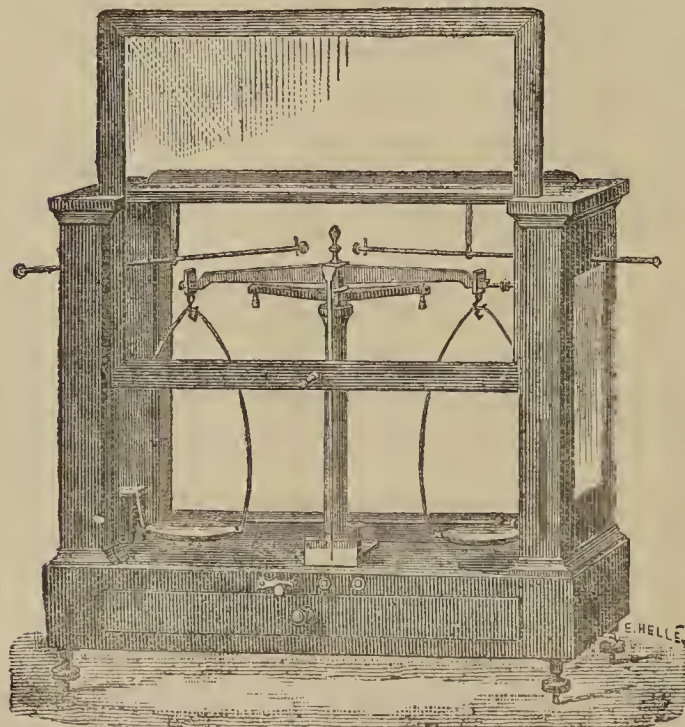
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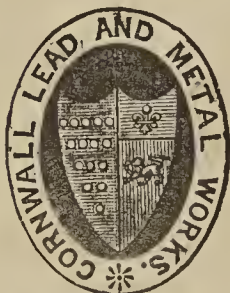
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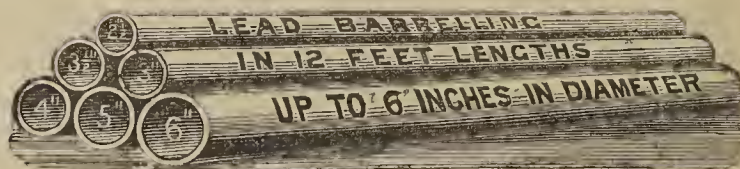
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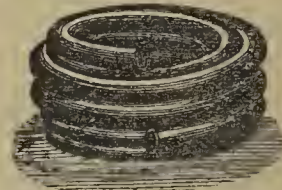


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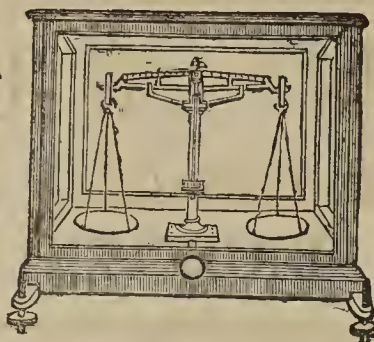
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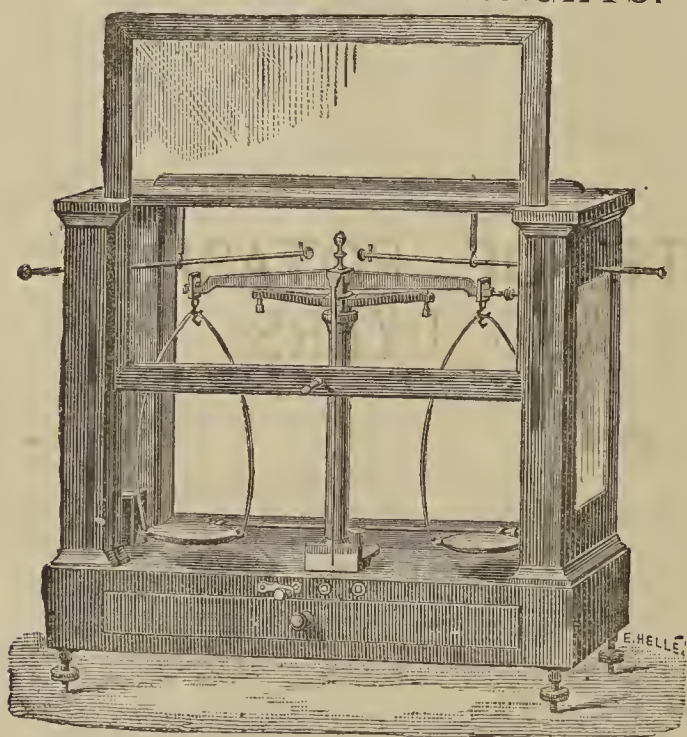
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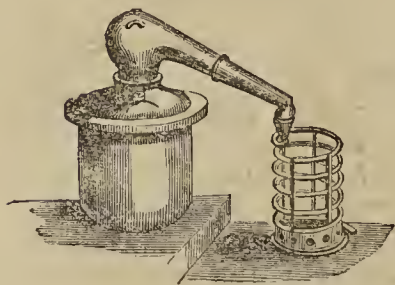
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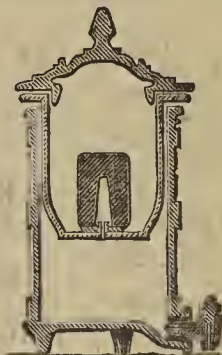
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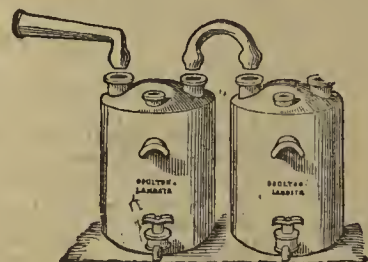
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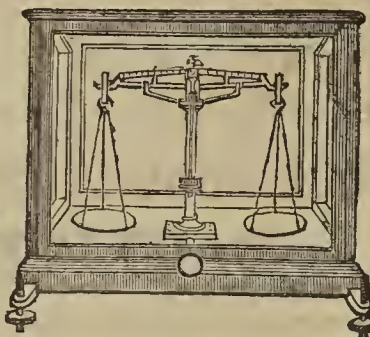
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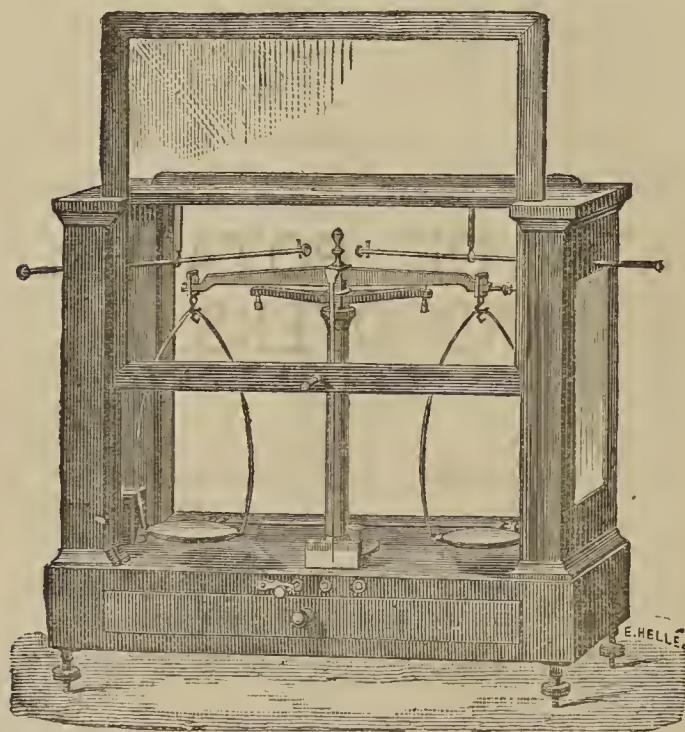
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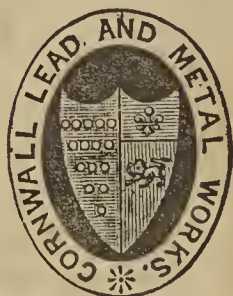
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Carbonate of Soda	1.31	1.35
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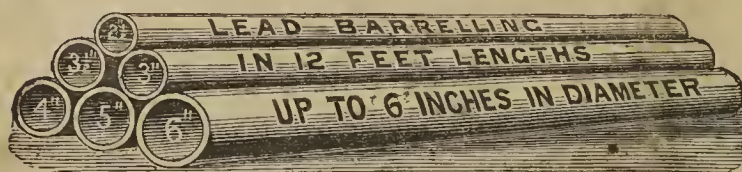
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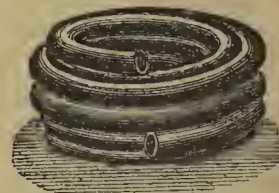


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THE CHEMICAL NEWS.

VOLUME XLVIII.

EDITED BY WILLIAM CROOKES, F.R.S., &c.

No. 1232.—JULY 6, 1883.

ON LINE SPECTRA OF BORON AND SILICON.*

By W. N. HARTLEY, F.R.S.E., &c.,
Royal College of Science, Dublin.

In the course of an extended examination of all varieties of saline solutions by means of the spark and a photographic camera, I have observed two spectra of much interest. I detach my notes from the paper in which they are embodied in order to give them an earlier publication.

Boron.—In order to ascertain whether sodium borate would yield any spectrum beyond that due to sodium, a strong solution of borax was first examined and subsequently a saturated solution of boracic acid. The graphite electrodes with which the solution was submitted to the action of the spark, was opposed to a pole of a tin-cadmium alloy, in order that the wave-lengths of any lines that might appear could be determined by reference to those of tin and cadmium. It is a remarkable fact that when a saturated solution of borax is used, the sodium lines are not visible, while there appear three strong sharp lines, which as they were likewise yielded by boracic acid, must be considered as characteristic of boron.

The Spectrum of Boron.

Scale numbers.	Wave-lengths.
96·18	3450·3
269·20	2497·0
269·48	2496·2

Silicon.—A strong solution of sodium silicate was in like manner submitted to the action of the spark. There was only a feeble indication of the strongest sodium line ($\lambda = 3301$), but a strong spectrum was obtained consisting of a beautiful group of lines with three isolated rays. These lines are attributed to silicon, because they are rendered equally well by sodium silicate, sodium fluosilicate, and by hydrofluosilicic acid, the electrodes being either of gold or of carbon. The strength of the lines is proportional to the strength of the hydrofluosilicic acid solution examined. The fiducial lines of the tin-cadmium alloy and some of the air lines were employed as before in obtaining measurements from which the wave-lengths of the silicon lines were calculated by means of an interpolation curve. Below are given the wave-lengths of the silicon lines, together with their scale numbers referring to their position and the prism spectrum. The scale

numbers are comparable with those given in a paper recently submitted to the Royal Society, and are also applicable to my photographs of spectra in the *Journal of the Chemical Society*, vol. 41, p. 90. They represent hundredths of an inch and fractions thereof, reckoned from a strong air line with wave-length 4628·9, which is numbered 10. (Measurements of the Wave-lengths of Lines of High Refrangibility in the Spectra of Elementary Substances": Hartley and Adeney.)

The Spectrum of Silicon.

Scale numbers.	Wave-lengths.
178·98	2881·0
233·17	2631·4
256·78	2541·0
260·36	2528·1
261·65	2523·5
263·07	2518·5
263·98	2515·5
264·44	2513·7
266·54	2506·3
288·00	2435·5

These are the first spectra of boron and silicon obtained from metallic salts. In Messrs. Liveing and Dewar's map of the carbon spectrum (*Proc. Roy. Soc.*, vol. 33, p. 403), I have observed a group of lines not seen in the spectrum of graphite obtained by me (*Journal of the Chemical Society*, vol. 41, p. 90), which might be accounted for by a difference in strength of the spark employed. This group, however, resembles in a striking manner the seven lines in the spectrum of silicon. (See the map of the silicon spectrum.) Their wave lengths are the following—2541·0, 2528·2, 2523·6, 2518·7, 2515·8, 2514·0, 2506·3. It will be seen by comparison that these lines approximate so closely to those of silicon that the numbers are well within the experimental errors of measurement of identical lines. Professors Liveing and Dewar took the lines which they mapped from sparks passed "between poles of purified graphite in air, carbonic acid gas, hydrogen, and coal gas. The same lines have been observed in photographs of the spark between iron, and between aluminium poles in carbonic acid gas." "The graphite was purified by being stirred in fine powder into fused potash, and subsequent treatment with *aqua regia*, by prolonged ignition in a current of chlorine, and by treatment with hydrofluoric acid." "Notwithstanding the purification the photographs of the spark between these electrodes still showed very distinctly the lines of magnesium and iron."

* A Paper read before the Royal Society, June 21, 1883.

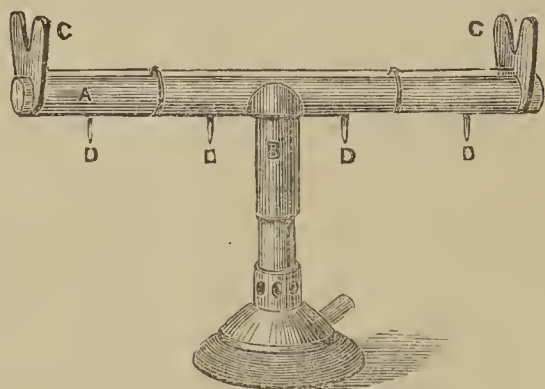
From these quotations it will be seen with what great care the preparations for these observations on the carbon spectrum were made. If the poles employed had been those of graphite only, I should have had little hesitation in attributing the six lines to the silicon spectrum, but they were replaced by iron and by aluminium. Even the purest iron wire contains small traces of silicon, and aluminium of the usual commercial quality certainly contains a considerable quantity. There is, therefore, a suspicion that the carbon spectrum was contaminated by silicon, for a series of seven consecutive lines so nearly coincident with those in the spectrum of another element of the same class would be very remarkable.

A LONG-FLAME BUNSEN BURNER.

By W. RAMSAY, Ph.D.

I HAVE long felt the want of a Bunsen's burner which should heat short lengths of combustion-tubing to redness for such purposes as incinerating weighed amounts of ash containing carbon, separating small amounts of elements which form volatile chlorides from elements the chlorides of which do not volatilise at a red heat, and for similar operations. Such a burner should be easy to manipulate, efficient, and inexpensive. I have devised the form represented in the annexed figure, which, I think, fulfils these requirements.

It consists of a brass tube, A, with a brass T-piece, which can be fitted on to an ordinary Bunsen's burner, at



right angles to the tube A. The horizontal tube is slit from end to end; it is closed at both ends, and provided with supports, c c, in which the glass tube rests. As a substitute for stopcocks are four pieces of wider brass tubing which encase A, also slit along top, provided with brass pegs, d d d d, by means of which each can be moved so that the slit in A no longer coincides with the slits in the encasing tube. When the two slits coincide there is free passage for gas; but when the external tubes are made to revolve on A the gas is shut off, and the flame is extinguished. Each encasing tube is 2 inches long, the whole tube being $8\frac{1}{2}$ inches in length. At one end of A a circular piece of brass projects for $\frac{3}{16}$ ths of an inch, and on the lower side a short peg is inserted. On the other end there is a corresponding annular projection, designed to receive the circular projection of another burner; in the ring there is a slot into which the peg from the second burner fits. The object of this is to connect one burner with another so as to form a furnace of a series of three or four burners. Such a series answers the purpose of an ordinary combustion-furnace, and has the following advantages:—It is much less cumbrous; the gas can be more conveniently regulated than in an ordinary furnace, and combustion-tubes consequently last for a longer time; there is no disagreeable smell, so that a combustion-room is not required; the combustion can therefore be performed on an ordinary laboratory bench; and the length of the furnace

can be modified by using as many or as few burners as desired. There is, moreover, no danger of the flame "burning below"; it is a clear blue flame.

For organic analysis it is advisable to have special Bunsen's burners, giving flames about 10 inches high, else the temperature is not sufficiently high; but the combustion-tube must then be protected with wire-gauze. To prevent upward radiation of heat it is convenient to lay on the top of the tube several long pieces of asbestos cardboard: these are easily removed by crucible-tongs during the combustion; hence its progress is easily watched.

By performing the combustion in an open tube, in a stream of oxygen, it is easy to complete four in a day of six hours with a double set of absorbing tubes and bulbs; and indeed a rapid worker may accomplish seven. This, of course, depends on the nature of the substance burned; but with bodies which have a large carbonaceous residue when heated, such as sugar, no attention is needed after the first evolution of gas has ceased, and while the combustion is proceeding the second set of tubes may be weighed.

I have only to add that the flame may be regulated by turning the external tubes quite as well, if not better than, with stopcocks.

University College, Bristol, June 24, 1883.

RUSSIAN BASIC STEEL.

By SERGIUS KERN, M.E., St. Petersburg.

It was a very interesting object for the writer to test the qualities of the basic steel of Russian manufacture. Near St. Petersburg, the Alexandrovsky Steel Works are commercially working the basic process in Siemens-Martin furnaces.

The plate steel welds quite like iron; in fact the Nevsky Works, St. Petersburg, rolling the ingots, make, out of the remaining scrap, piles which heated to a welding heat are rolled into capital plates for different purposes.

The following are the results of trials of the steel plates:—

Unannealed Plate.		
Thickness in inches.	Breaking weight: Tons per Square Inch.	Elongation in 8 Inches. Per cent.
$\frac{1}{2}$	26	29
Annealed Plate.		
$\frac{1}{2}$	22	36.25

The chemical composition of the steel runs as follows:—

	Per cent.
Carbon	0.10
Manganese	0.43
Phosphorus	0.02
Sulphur	0.02
Silicon	traces
Copper	none

I am informed that the raw materials charged into the furnace contain, on the average, 0.75 per cent of phosphorus.

I am very happy to state that the great invention of Messrs. Thomas and Gilchrist is worked in Russia in such a satisfactory way.

Panification.—V. Marcano.—The author has never been able to find in fermenting bread any trace of *saccharomyces*. The organism common in it is a movable spherobacterium. During the process of panification the gluten and a part of the albumenoids are partially dissolved and converted into peptones, not precipitable by tannin. There is also formed amylase, a secretion-product of the microbia.—*Comptes Rendus*.

A RECALCULATION
OF
THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Professor of Chemistry and Physics in the University of Cincinnati.

SILVER, POTASSIUM, SODIUM, CHLORINE,
BROMINE, IODINE, AND SULPHUR.

THE atomic weights of these seven elements depend upon each other to so great an extent that they can hardly be considered independently. Indeed, chlorine, potassium, and silver have always been mutually determined. From the ratio between silver and chlorine, the ratio between silver and potassium chloride, and the composition of potassium chlorate, these three atomic weights were first accurately fixed. Similar ratios more recently worked out by Stas and others, have rendered it desirable to include bromine, iodine, sulphur, and sodium in the same general discussion,

Several methods of determination will be left altogether out of account. For example, in 1842 Marignac* sought to fix the atomic weight of chlorine by estimating the quantity of water formed when hydrochloric acid gas is passed over heated oxide of copper. His results were wholly inaccurate, and need no further mention here. A little later Laurent† re-determined the same constant from the analysis of a chlorinated derivative of naphthalene. This method did not admit of extreme accuracy, and it presupposed a knowledge of the atomic weight of carbon; hence it may be properly disregarded. Maumené's‡ analyses of the oxalate and acetate of silver gave good results for the atomic weight of that metal; but they also depend for their value upon our knowledge of carbon, and will, therefore, be discussed further on with reference to that element.

Let us now consider the ratios upon which we must rely for ascertaining the atomic weights of the seven elements in question. After we have properly arranged our data we may then discuss their meaning. First in order we may conveniently take up the percentage of potassium chloride obtainable from the chlorate.

The first reliable series of experiments to determine this percentage was made by Berzelius.¶ All the earlier estimations were vitiated by the fact that when potassium chlorate is ignited under ordinary circumstances a little solid material is mechanically carried away with the oxygen gas. Minute portions of the substance may even be actually volatilised. These sources of loss were avoided by Berzelius, who devised means for collecting and weighing this trace of potassium chloride. All the successors of Berzelius in this work have benefitted by his example; although for the methods by which loss has been prevented we must refer to the original papers of the several investigators. In short, then, Berzelius ignited potassium chlorate, and determined the percentage of chloride which remained. Four experiments gave the following results:—

60·854
60·850
60·850
60·851

Mean .. 60·851 with a probable error
of $\pm 0·0006$

The next series was made by Penny,¶ in England, who worked after a somewhat different method. He treated potassium chlorate with strong hydrochloric acid in a weighed flask, evaporated to dryness over a sand-bath, and then found the weight of the chloride thus obtained. His results were as follows in six trials:—

* Smithsonian Miscellaneous Collections. "The Constants of Nature."

† Comptes Rendus, 14, 570. Also, Jour. f. Prakt. Chem., 26, 304.

‡ Comptes Rendus, 14, 456. Jour. f. Prakt. Chem., 26, 307.

§ Ann. d. Chim. et d. Phys., (3), 18, 41. 1846.

|| Pogg. Annalen, 1826, bd. 8, s. 1.

¶ Phil. Transactions, 1839, p. 20.

60·825
60·822
60·815
60·820
60·823
60·830

Mean .. 60·8225 $\pm 0·0014$

In 1842 Pelouze* made three estimations by the ignition of the chlorate with these results:—

60·843
60·857
60·830

Mean .. 60·843 $\pm 0·0053$

Marignac, in 1842,† worked with several different re-crystallisations of the commercial chlorate. He ignited the salt, with the usual precautions for collecting the material carried off mechanically, and also examined the gas which was evolved. He found that the oxygen from 50 grammes of chlorate contained chlorine enough to form 0·003 gm. of silver chloride. Here are the percentages found by Marignac:—

In chlorate once crystallised 60·845
In chlorate once crystallised 60·835
In chlorate twice crystallised 60·833
In chlorate twice crystallised 60·844
In chlorate three times crystallised .. 60·839
In chlorate four times crystallised .. 60·839

Mean .. 60·8392 $\pm 0·0013$

In the same paper Marignac describes a similar series of experiments made upon potassium perchlorate, KClO_4 . In three experiments it was found that the salt was not quite free from chlorate, and in three more it contained traces of iron. A single determination upon very pure material gave 46·187 per cent. of oxygen and 53·813 of residue.

In 1845 two series of experiments were published by Gerhardt.‡ The first, made in the usual way, gave these results:—

60·871
60·881
60·875

Mean .. 60·8757 $\pm 0·0020$

In the second series the oxygen was passed through a weighed tube containing moist cotton, and another filled with pumice stone and sulphuric acid. Particles were thus collected which in the earlier series escaped. From these experiments we get:—

60·947
60·947
60·952

Mean .. 60·9487 $\pm 0·0011$

These last results were afterwards sharply criticised by Marignac,§ and their value seriously questioned.

The next series, in order of time, is due to Maumené.¶ This chemist supposed that particles of chlorate, mechanically carried away, might continue to exist as chlorate undecomposed; and hence that all previous series of experiments might give too high a value to the residual chloride. In his determinations, therefore, the ignition tube, after expulsion of the oxygen, was uniformly heated in all its parts. Here are his percentages of residue:

* Comptes Rendus, 15, 959.

† Ann. d. Chem. u. Pharm., bd. 44, s. 18.

‡ Comptes Rendus, 21, 1280.

§ Supp. Bibl. Univ. de Genève, vol. I.

|| Ann. d. Chim. et d. Phys., (3), 18, 71. 1846.

60.788
60.790
60.793
60.791
60.785
60.795
60.795

Mean .. 60.791 \pm 0.0009

The question which most naturally arises in connection with these results is, whether portions of chloride may not have been volatilised, and so lost.

Closely following Maumené's paper there is a short note by Faget,* giving certain mean results. According to this chemist, when potassium chlorate is ignited slowly, we get 60.847 per cent of residue. When the ignition is rapid we get 60.942. As no detailed experiments are given, these figures can have no part in our discussion.

Last of all we have two series determined by Stas.† In the first series we have the results obtained by igniting the chlorate. In the second series the chlorate was reduced by strong hydrochloric acid, after the method followed by Penny:—

First Series.

60.8380
60.8395
60.8440
60.8473
60.8450

Mean .. 60.84276 \pm 0.0012

Second Series.

60.850
60.853
60.844

Mean .. 60.849 \pm 0.0017

(To be continued.)

SOME NOTES ON THE CINCHONA ALKALOIDS: A TEST FOR THE PURITY OF QUININE.

By C. H. WOOD and E. L. BARRET.

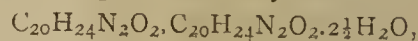
I. Hydrate of Quinine and Quinidine.—In the CHEMICAL NEWS (vol. lxx., p. 6) we briefly describe a crystalline compound of quinine and quinidine that we had obtained from a solution of the two alkaloids in ether. Our results indicated that the quinine and quinidine were present in this crystalline body in equal proportions, but they had been roughly obtained, and were not sufficiently exact to warrant any very positive statement on this point. We have now prepared this compound in several ways and are able to furnish more accurate results.

1. Ten grammes of pure effloresced quinine sulphate, prepared from calisaya bark, were dissolved in acidulated water, and the solution shaken in a bottle with 170 c.c. of pure ether. An excess of sodic hydrate solution was then added and the whole shaken together. When the precipitated quinine had dissolved in the ether and the two layers had separated, a few c.c. of alcohol were poured into the ether to prevent gelatinisation, and the lower aqueous liquid was syphoned out. The clear ethereal solution was decanted into a large bottle. Ten grammes of pure quinidine sulphate were dissolved in acidulated water and the solution shaken in a bottle with 900 c.c. of pure ether, an excess of sodic hydrate solution added,

and the whole shaken together. When the precipitate had dissolved in the ether and separation had occurred, the aqueous liquid was syphoned out, the ethereal solution decanted into a clean vessel, and then poured into the bottle containing the ethereal solution of the quinine hydrate. A few minutes after mixing these ethereal solutions groups of small crystals began to form on the sides of the bottle, and by next day an abundant crystalline precipitate had formed. This was collected on a filter, washed with fresh ether, pressed between bibulous paper, and dried by exposure to the air. It weighed 13 grms. The ethereal filtrate and washings were distilled down to about 250 c.c., and this concentrated mother-liquor, after some hours, deposited a further crop of crystals exactly resembling the first. The liquor decanted from these was distilled to dryness and left a residue, which gradually became perfectly crystalline. Analyses of the first crop of crystals obtained gave the following results:—

Quinine	47.06 ..	46.91 ..	47.29
Quinidine	45.96 ..	46.29 ..	46.36
Water	6.98 ..	6.80 ..	6.35
	100.00	100.00	100.00

These numbers agree sufficiently well with



which corresponds to—

Quinine	46.753
Quinidine	46.753
Water	6.494
	100.000

By exposure in a desiccator for five or six days the crystals lost the half molecule of water. The second crop of crystals obtained in the foregoing operation agreed with the first in composition.

2. Equal quantities of quinine and quinidine (alkaloid) were dissolved together in ten times their joint weight of weak spirit (sp. gr. 900=58 per cent by weight) by the aid of heat, and the solution left to crystallise. Prismatic crystals soon began to form. Next morning the liquid was decanted, the crystals drained, dried quickly by pressing between bibulous paper, and analysed. They gave—

Quinine	46.29
Quinidine	45.55
Water	8.16
	100.00

Three molecules of water to the two molecules of alkaloid (648+54) require only 7.69 per cent. Probably, therefore, the crystals retained a little external moisture when taken for analysis. A portion of the same crystals exposed in a desiccator over sulphuric acid for forty-eight hours lost 1.51 per cent, retaining 6.65 per cent of water. Consequently in this state they corresponded very closely with the crystals obtained from ether. The remainder of the crystals from spirit not used for analysis were again dissolved in ten parts of weak spirit of the same strength, and the solution left to crystallise. The resulting crystals dried as before gave on analysis numbers almost identical with those just stated for the first crystallisation.

3. Two grms. of quinidine sulphate were dissolved in acidulated water and the solution put in a bottle with 60 c.c. of pure benzene, warmed to about 40°C, and sodic hydrate solution added in excess. The mixture was well shaken, and when the precipitate had dissolved in the benzene and separation of the two liquids had occurred, the lower layer was syphoned out, and the benzene solution filtered. Two grms. of effloresced quinine sulphate were then treated in the same way, but using 90 c.c. of benzene instead of 60. To this filtered benzene solution, while still warm and before it crystallised, the benzene

* *Ann d. Chim. et d. Phys.*, (3), 18, 80. 1846.

† See Aronstein's "Translation," 249.

solution of quinidine prepared as above was added. As the mixture became cloudy it was warmed till clear, and then left. A crystalline precipitate soon began to form, and next day this was collected on a filter and pressed between bibulous paper till apparently dry, when it weighed 4·6 grms. Left in a loosely covered vessel, it weighed on the following day 3·42, and two days after 3·23 grms. In this state it was analysed, and gave the following results:—

Quinine	42·56
Quinidine	41·82
Water	4·91
Benzene	10·71
	<hr/>
	100·00

The formula $C_{20}H_{24}N_2O_2 \cdot C_{20}H_{24}N_2O_2 \cdot 2H_2O + C_6H_6$ requires—

Quinine	42·52
Quinidine	42·52
Water	4·72
Benzene	10·24
	<hr/>
	100·00

As the apparently dry substance had been exposed for three days in such a manner that evaporation could occur before it was analysed, it seemed evident that at least one molecule of benzene was a constituent of the crystals, and it is even possible that when first removed from the liquid they contained more than one molecule.

From the foregoing results it was seen that the body which we have described as a compound of quinine and quinidine, when prepared as indicated from ether, from weak spirit, or from benzene, always contains water, and is therefore a hydrate of the two alkaloids. We noticed in analysing the body that the quinine and quinidine together, when rendered anhydrous, had a notably lower fusing-point than either alkaloid has alone. This fused and anhydrous body, when dissolved by a gentle heat in 12 parts of pure well-dried benzene and the flask securely corked, formed a solution which after standing ten days had only yielded a slight crystalline precipitate too small in quantity to be worth collecting. On removing the cork, however, and leaving the solution exposed to the air, a copious crystalline precipitate soon formed, and in a couple of days the liquid was half filled with it. This, collected on linen, pressed, dried on bibulous paper, and analysed, gave 4·30 per cent. of water and 16·55 of benzene. It would appear from this that the anhydrous alkaloids in benzene are capable of absorbing water from the air to form the hydrate.

II. *Quinine Hydrate Crystallised from Benzene.*—Thirty grammes of quinine sulphate were dissolved in acidulated water, 900 c.c. of pure benzene added to the solution, and the whole warmed in a bottle to about 40° C. Excess of sodic hydrate solution was then poured in and the mixture well shaken. The precipitate dissolved completely in the benzene, and when the two liquids had separated the lower layer was removed by a syphon, and the benzene solution quickly passed through a filter into a dry beaker. As this solution cooled it began to deposit rhombic crystals, and after standing for twelve hours had yielded a plentiful crop. The liquid was then decanted, the crystals drained and turned on to bibulous paper to dry. When all the adherent moisture had gone they weighed 25 grammes. They were put in a dish loosely covered with a glass plate, left for two or three days, and then preserved in a bottle. Analysed after some weeks they gave—

Quinine	83·99
Water	4·70
Benzene	11·31
	<hr/>
	100·00

A fresh quantity prepared in the same way gave—

Quinine	82·07
Water	4·68
Benzene	13·25
	<hr/>
	100·00

The crystals as they first form are small separate rhombs, closely resembling those which cinchonidine yields from an ethereal solution; but in growing they have a tendency to become longer and more prismatic. The first analysis we have given approximates sufficiently well to the formula $2C_{20}H_{24}N_2O_2 \cdot 2H_2O + C_6H_6$, which requires—

Quinine	85·04
Water	4·72
Benzene	10·24
	<hr/>
	100·00

And it indicates, therefore, that quinine hydrate crystallised from benzene agrees in general composition with the quinine and quinidine hydrate crystallised from the same menstruum. In both cases two molecules of alkaloid appear to be associated with two molecules of water and one of benzene. As these crystals, however, slowly lose benzene by exposure, there is the same sort of difficulty in determining the amount of benzene associated in the crystal that occurs in estimating the water of crystallisation of an efflorescent salt. That the benzene is inherent to the constitution of the crystals seems to us certain, for we have a sample of these quinine hydrate crystals prepared at least nine months back and since preserved in a loosely corked bottle standing on an upper shelf of a warm laboratory, that are devoid of all odour of the hydrocarbon, but are unchanged in appearance, and when dissolved in a little dilute acid in a test-tube still liberate benzene, which rises to the surface of the aqueous liquid, forming a visible layer. This sample was not analysed because it was not prepared from specially purified benzene. To get some idea, however, of the rate at which the crystals lose their benzene, about 3½ grammes of the first batch of crystals, the analysis of which is given above, were rubbed to fine powder, which was spread over a glass dish and exposed in vacuo. In the first twenty-four hours the loss was 0·95 per cent, in the second 0·44 per cent, and in the third 0·34 per cent. The dish was then placed under a larger receiver and left there for thirty-seven days. At the end of that time (forty days in all) the powder was found to retain 4·65 per cent. of benzene. The crystals in their unbroken state do not undergo so much change as the powder, and may be kept in an ordinary bottle without any apparent alteration.

III. *Quinine Crystallised from Benzene.*—When the crystals of the quinine hydrate from benzene are re-dissolved by heat in pure well-dried benzene, the solution on cooling deposits crystals of the hydrate in the same form as before, but mixed with acicular masses quite distinct in appearance. These needle-like crystals seemed to be formed from anhydrous quinine, and the following experiment was therefore made:—About 7 grammes of anhydrous quinine were dissolved by heat in 140 c.c. of pure dry benzene. When the solution had cooled, a minute fragment of a crystal of the quinine hydrate was dropped in. Crystallisation soon commenced, but entirely in the acicular form. After twelve hours a good crop of needles was obtained. These drained and pressed between fresh pieces of bibulous paper till they were apparently dry and then analysed, gave—

Quinine	76·58
Water	0·25
Benzene	23·17
	<hr/>
	100·00

A portion of the crystals exposed in a watch-glass under a large receiver lost in nineteen hours 5.04 per cent, in another twenty-three 2.16 per cent, and again in eight days 4.15 per cent, making a total loss in ten days of 11.35 per cent, or about half the total quantity of benzene originally present. The rate of loss was most rapid during the first nineteen hours, and from that period rapidly diminished; if, therefore, the first loss of 5.04 be deducted from the benzene found in the original crystals, there remains—

Quinine	76.58
Benzene	18.13

which would be almost exactly the proportions required for $C_{20}H_{24}N_2O_2 + C_6H_6$.

IV. *Cinchonidine Crystallised from Benzene*.—One part of pure cinchonidine was dissolved in 60 parts of pure benzene at the boiling temperature, and the solution allowed to cool. An abundance of acicular crystals was obtained. Dried on bibulous paper as before and analysed, they gave—

Cinchonidine ..	79.95
Benzene	20.05
<hr/>	
	100.00

These numbers agree closely with $C_{20}H_{24}N_2O + C_6H_6$, but the crystals lose their benzene very rapidly. After fifteen days' exposure under a large receiver they contained 8.58 per cent, and after a few weeks only 1.76 per cent. A solution of cinchonidine sulphate shaken with warm benzene and soda, furnished a solution that yielded the same kind of acicular crystals containing, as was to be expected, no water.

The benzene used in the foregoing experiments was specially purified by taking well crystallised benzene, washing it with strong solution of potash, and distilling it over potassic hydrate, then digesting it at its boiling-point with 5 per cent of its weight of pure sulphuric acid, repeating the latter treatment till the acid ceased to acquire any sensible colour, then washing again with alkali, and distilling from potassic hydrate. To this product sufficient pure bromine was added to give it a permanent colour, and the washing with alkali, &c., repeated. The resulting benzene, when well dried, had a constant boiling point from the beginning to the end of the distillation, and in this state was used. The analysis of the bodies crystallised from benzene was effected by weighing the substance in a small two-necked flask, which was then placed in an oil-bath, and the temperature gradually raised to 140° C., while a slow current of well-dried air was passed through the flask and through three successive weighed $CaCl_2$ tubes attached to the exit neck of the flask. The current was continued until the exit air was free from the odour of benzene. The weight of the residue in the flask gave the percentage of alkaloid; the increase in the weight of the $CaCl_2$ tubes gave the water, and the difference of these two from the total gave the benzene.

V. *Quinine Hydrate and Cinchonidine from Benzene*.—

A *Test for the Purity of Quinine*.—The foregoing results show that when a solution of quinine is precipitated by an alkali and shaken with warm benzene, the quinine hydrate dissolves and crystallises out again from the benzene in rhomboidal crystals. A solution of cinchonidine treated in the same way yields acicular crystals devoid of water. If a solution of quinine containing cinchonidine—say 10 per cent—be submitted to the same process, the benzene yields first the characteristic crystals of quinine hydrate and afterwards feathery groups of delicate needles. By removing the clear benzene into another vessel as soon as the bulk of the quinine hydrate has deposited, these acicular crystals may be obtained separately. They do not consist of cinchonidine alone, however, but contain quinine and cinchonidine crystallised together, the quinine being, in fact, the preponderating constituent. As

the difference between these crystals and those of the quinine hydrate is very distinct, particularly when the crystals are examined through a pocket lens, it seemed possible to found upon it a method for the detection of cinchonidine in quinine. The result of experiments in this direction appears to us to be attended with a fair amount of success. The following is the mode of operating we have adopted:—Seven decigrammes of the quinine sulphate to be tested are put into a large test-tube and dissolved in twenty drops of diluted hydrochloric acid and 7 c.c. of water; 7 c.c. of benzene are then added and the tube placed in warm water, so as to heat the benzene layer to about 60° or 70° C.; $3\frac{1}{2}$ c.c. of diluted ammonia are then poured in and the tube well shaken for about twenty seconds. The two liquids are allowed to separate from each other, and the lower layer is removed by a glass syphon filled with water. The tube containing the benzene solution is left at rest for about half an hour, or until the quinine hydrate has crystallised out, when the benzene is poured off through a little dry filter into a small dry test-tube (4 in. \times $\frac{1}{2}$ in.), and again left to crystallise. A few rhombic crystals of the quinine hydrate may occasionally again form, but these are to be disregarded. If the quinine sulphate contained 5 per cent of cinchonidine, within half an hour several feathery groups of delicate needles will begin to appear in the liquid, and these will increase so that after an hour or so they are abundant throughout the tube. With 2 per cent. of cinchonidine the formation of these crystals takes a longer time, but is generally quite distinct after two or three hours; and with 1 per cent, a few small groups can usually be found by a pocket-lens after three or four hours, and in twelve hours are quite visible. Smaller proportions of cinchonidine than even this are revealed after some days as the benzene slowly evaporates. When the quinine has been rigidly pure we have never found a trace of acicular crystals in the liquid, even after many days when the benzene has almost all gone. It is to be noted that the crystals should be looked for *within the liquid*, as the residue left on the upper part of the tube by the evaporation may give an erroneous impression. We have shown in Paragraph III. that it is possible to obtain acicular crystals of pure quinine from benzene under certain conditions. It is important to remember, therefore, that in using this test the method of operating given above must be strictly followed. But if this be done, and some experience of the appearance of the two sorts of crystals through a pocket lens has been acquired, we have reason to believe that the results obtained are trustworthy, and constitute a fair indication of the purity or otherwise of the quinine tested. For the purposes of this test absolutely pure benzene is not essential. The best benzene of commerce that will crystallise readily when put in a freezing mixture is sufficient. For pharmaceutical purposes the following proportions will probably be more convenient:—Ten grains of the quinine are dissolved in 20 minims of dilute hydrochloric acid P.B. and 2 fl. drms. of water. Two fl. drms. of benzene are added and the tube put in warm water to raise the benzene layer to a temperature of about 140° F. One fl. drm. of liq. ammonia P.B. is then added, and the test conducted as given above.

Royal School of Mines.—The third award of the medal and prize of books, given in 1881 by Sir Henry Bessemer, F.R.S., for the best Metallurgical Student of the year, has been made to Mr. H. F. Collins, who has just received an appointment as Assistant Resident Chemist at the important works of Rio Tinto, in Spain. The report for the current year of the Professor of Metallurgy points to the growing prosperity of the School of Mines and to the efforts that are being made, by visits to the metallurgical districts, to assimilate its teachings to that given in similar institutions on the Continent.

A NEW VOLUMETRIC METHOD FOR
ESTIMATING ARSENIC.*

By LEROY W. McCAY, M.A., D.Sc.

At Freiberg, in Saxony, the following arsenic estimation method, first suggested by Reich and afterwards developed by Richter, is in vogue:—0.5 grm. of the finely pulverised ore is digested in a porcelain crucible, covered with a watch-glass, with concentrated nitric acid, and under the influence of heat until the residue assumes a lighter colour, and the sulphur, which separates out, has become of a pure yellow hue. After decomposition the watch-glass is rinsed with a few drops of water and the uncovered crucible heated upon the sand-bath in order to get rid of the excess of acid. A complete evaporation must be avoided. Four grms. of sodic carbonate are now added, the mass completely dried upon the sand-bath, 4 grms. of potassic nitrate introduced into the crucible, and the same heated until its contents flow quietly. The melted mass is permitted to remain in this state for ten minutes. After the crucible is cool it is brought into a dish and the fused mass extracted with hot water. The alkaline liquid, which contains the arsenic as arseniate of sodium, is acidified with a small amount of nitric acid, placed for two hours upon a hot sand-bath, in order to get rid of the carbon dioxide, mixed thereupon with a sufficient amount of silver solution (10 c.c. of a solution containing 100 grms. to the litre), and then neutralised with a dilute solution of ammonium hydroxide. Reddish brown arseniate of silver is precipitated. The precipitate is filtered, washed, well dried, shaken from the filter upon glazed paper, and the folded filter brought into a scarifier, and ashed in the glowing muffle. After the scarifier is cold the precipitate is shaken into the same, charged with ten assay tons of lead, and the silver determined in the usual way. From the silver found the amount of arsenic present is readily calculated. 100 grms. Ag = 23.1 grms. As.

So much for Reich and Richter.

The process here described is not in "Fresenius's Anleitung zur Quantitativen Chemischen Analyse," and for this very reason I have always been accustomed to regard it as only capable of affording approximate results. Results, in other words, perfectly satisfactory as far as the technical world is concerned, but in no wise in strict accordance with thoroughly scientific demands. Being unable to discover anything in detail as respects the method, I determined to look into the matter myself, and, if possible, settle my mind in regard to its perfections or imperfections.

The first question which appeared most worthy of consideration was whether the arsenic is completely precipitated upon the addition of the silver solution and subsequent neutralisation with ammonium hydroxide. A concentrated solution of ammonium arseniate was added to a strong solution of argentic nitrate, until the silver proved to be in excess, then neutralised with ammonium hydroxide, filtered, and washed. The silver contained in the filtrate was precipitated with hydrochloric acid, filtered off, the filtrate heated to boiling, and a stream of sulphuretted hydrogen permitted to pass through the liquid during an entire night. A small but perfectly distinct precipitate of yellow sulphide of arsenic was found

at the bottom of the beaker. Four similar trials were made and in each case definite amounts of sulphide were forthcoming. This goes to prove that although the solution may be perfectly neutral *as far as its action upon litmus-paper* is concerned, some arsenic as arseniate of silver is sure to remain in solution. Concerning this point I find nothing in Post's description of Reich and Richter's method. All they say is, to neutralise carefully with dilute ammonium hydroxide.*

To bring down all the arsenic, avoid a re-dissolving of a portion of the same, and, at the same time, keep clear of a precipitation of silver oxide, I hit upon the following method of procedure:—Argentic nitrate was added in excess to a solution of ammonium arseniate, the same heated to boiling, and briskly stirred with a glass rod, first in one direction and then in another, until the liquid began to clear. It was then removed from the flame, cooled down to about blood heat, brought under a clip burette, and a very dilute solution of ammonium hydroxide (10:1) allowed to run in drop by drop until a cloud no longer appeared. In adding the ammonium hydroxide, after every two or three drops the liquid was thoroughly stirred, the precipitate permitted to settle, and the process continued until the last drop no longer produced a cloud. The precipitate was then filtered off and the filtrate tested for arsenic. Not a trace was discoverable. Numerous experiments were made, but when the conditions were properly complied with, absolutely no arsenic could be found by using sulphuretted hydrogen and Bunsen's flame reaction. Silver oxide is precipitated by ammonium hydroxide from a neutral solution of a silver salt, and it is only upon the addition of an excess of the alkali that the precipitate can again be brought into solution. The question now arises, is there not danger of precipitating some silver along with the arsenic? If so, will this not serve to vitiate the method? To settle the matter, I took about 2½ c.c. of a strong solution of silver nitrate, diluted with water to about 50 c.c., and after heating to boiling, added a drop of the dilute ammonium hydroxide solution—no precipitate; two drops, no precipitate; three drops, no precipitate; twelve drops, none. The solution was next tested with litmus paper, but showed absolutely no alkaline reaction. When the ammonia was allowed to run in until the resulting reaction was faintly alkaline, a distinct cloud, due to the formation of silver oxide, made its appearance. This cloud, by permitting the solution to stand for some time, became larger and larger, but soon reached a maximum. In opposition, therefore, to Pearce and Low, I declare that the solution immediately prior to precipitation dare not be alkaline!

Fresenius says that argentic arseniate is slightly soluble in ammonium nitrate. I do not deny this fact, for it seems well established, but I must say that the amount of arseniate which does go into solution is so extraordinarily small that by the regular methods of analysis I have been unable to detect it. True, I have not made use of a Marsh apparatus, but, in the present case, I hardly deemed such precaution necessary.

The above points, then, being settled we can proceed.

As said Reich and Richter determine the silver contained in the arseniate by cupellation, and, from the weight of the silver button, estimate the arsenic. This will do very well for large works like the Freiburger-Hütten, where mufflers are running day and night, but in establishments not provided with furnaces of this kind, or in laboratories provided with them but only capable of firing up at certain seasons, the impossibility of a general and constant applicability of the process is at once evident.

To avoid this obstacle and at the same time render the method as *quick* as possible, I determined to make use

* This paper was already prepared for the press when Pearce and Low's investigations came to hand (*Science*, vol. i., No. 15). My method differs from theirs in that it is based upon the principle of *test*. My paper will serve to clear up several points which the above-named gentleman failed to completely ventilate. Such, for instance, as the relation existing between the argentic arseniate and ammonium nitrate, the exact degree of accuracy of the method, and lastly and chiefly, the device for hitting upon the precise moment at which the precipitation of the arsenic is most complete. It may perhaps be well to announce the fact that I first became acquainted with Pearce and Low's work about six hours ago. June 12th, 1883.

† Post: *Chemische-Technische Analyse*.

* Pearce and Low simply say:—Neutralise carefully with ammonia, taking care that the liquid, when ready for precipitation, shall show an *alkaline* rather than an acid reaction.

of the principle of rest*, *i.e.*, determine the excess of silver in the filtrate.

Concisely stated, the method of procedure is about as follows:—

To the neutral solution of arsenic acid, heated to boiling in a small beaker, add from a clip burette a small excess of a standard solution of silver nitrate. The liquid is then briskly stirred with a glass rod until the precipitate begins to settle and the fluid to clear, removed from the flame, and permitted to cool down to about blood heat. The beaker with its contents is then brought under a second clip burette containing a dilute solution of ammonium hydroxide, and the ammonia permitted to drop in gradually until a cloud ceases to form. The liquid is stirred well after the addition of every two or three drops of ammonium hydroxide, so as to obtain a clear menstruum in which the cloud formation is readily observed or not as the case may be. The point at which the cloud disappears can be hit upon with a great degree of exactness, especially since the precipitate of arseniate of silver, being warm and curdy, settles rapidly and completely. The reddish brown arseniate is then filtered off and washed well, the filtrate acidulated with nitric acid, ferric sulphate added, and the silver determined volumetrically with thiocyanate of ammonium, according to Vollhard's method. The amount of silver found subtracted from the amount added gives a figure, from which the arsenic is readily calculated:—

$$100 \text{ Ag} = 23.15 \text{ As.}$$

I use the following solutions:—

- (1) Ammonium hydroxide:
100 c.c. $(\text{NH}_4)\text{OH}$ to 1000 c.c. water.
- (2) Argentic Nitrate:
39.352 grms. $\text{Ag NO}_3 = 25$ grms. Ag to 1000 c.c. water.
- (3) Ammonium thiocyanate:
7.05 grms. to 1000 c.c. water.
1 c.c. = 0.00774 Ag .
- (4) Ammonium ferric sulphate:
500 c.c. water saturated in the cold with the salt.
- (5) Nitric acid:
Ordinary acid free from nitrous fumes.

I dissolved 4 grms. of ammonium arseniate in $\frac{1}{2}$ litre of water, and used for each determination 10 c.c.; theoretically 10 c.c. of this solution should contain 0.0380 gm. As . However, for the sake of accuracy, I made two analyses by precipitating the arsenic as the double arseniate of ammonium and magnesium, moistening the precipitate with nitric acid and glowing, gently at first but finally strongly.

The quantities taken and those found were:

	C.c. Taken.	Grms. $\text{Mg}_2\text{As}_2\text{O}_7$	Grms. As .
(1)	10	0.0671	0.0368
(2)	10	0.0671	0.0367
Average = 0.03675.			

10 c.c. were brought into a small beaker holding about 150 c.c., diluted to 50 c.c., and heated to boiling. 10 c.c. of the standard silver solution were then run in from the clip burette, the beaker removed from the flame, and its contents stirred diligently until the liquid cleared. After cooling down to blood heat the ammonia was added drop by drop until the precipitation proved to be complete. The cessation of the cloud formation serves to regulate this point. The washing was accomplished by decantation, about 25 c.c. being used each time. The filtrate was acidulated with 5 c.c. of the nitric acid (5), and, after the addition of 5 c.c. of the ferric sulphate solution,

titrated with ammonium thiocyanate. As soon as a faint red tinge proved permanent, the addition of the thiocyanate was discontinued, and the number of cubic centimetres used read off. The number of c.c. multiplied by 0.00774 gave the Ag in the filtrate, and this, subtracted from 0.25, the number of grms. of Ag which went to form the arseniate. This amount multiplied by 23.15 = the arsenic contained in the 10 c.c. of the ammonium arseniate. Eight determinations were made.

	C.c. taken.	C.c. Ag sol.	C.c. $\text{CNS}(\text{NH}_4)\text{ sol.}$	Grms. As present.	Grms. As found.
1.	10	10	12.1	0.03675	0.0362
2.	10	10	12.1	0.03675	0.0362
3.	10	10	12.0	0.03675	0.0364
4.	10	10	11.9	0.03675	0.0365
5.	10	10	12.1	0.03675	0.0362
6.	10	10	12.0	0.03675	0.0364
7.	10	10	11.9	0.03675	0.0365
8.	10	10	11.9	0.03675	0.0365

Average = 0.03635

0.03675 - 0.03635 = 0.0004 difference.

Having worked so admirably as regards a salt—and an ammonium salt at that—I determined to try the method in estimating the arsenic in mattes and minerals.

With this object in view, a nickel matte from Freiberg, in Saxony, was finely powdered, 0.2 gm. carefully weighed out, mixed with from four to five times its weight of a mixture of equal parts of sodic carbonate and potassic nitrate, and thoroughly fused in a large porcelain crucible and over a good Bunsen burner for thirty minutes. The crucible and contents were then allowed to cool and extracted with hot water. The oxides of bismuth, cobalt, nickel and iron, together with some silica and alumina, being filtered off and washed, the filtrate was slightly acidulated with nitric acid, heated so as to expel CO_2 , and then evaporated to dryness, and heated until acid fumes no longer appeared. The residue was taken up with water, the alumina and silica filtered off, and the whole filtrate diluted to 400 c.c. This amount was divided into two equal portions, and the arsenic determined as above described. Tabulated we have:—

	C.c. taken.	Grms. ore.	C.c. Ag sol.	C.c. $\text{CNS}(\text{NH}_4)\text{ sol.}$	Grms. Ag to form Ag_3AsO_4	Grms. As.	P. ct. As.
1.	100	0.0625	10	14.1	0.1410	0.03264	52.22
2.	100	0.0625	10	14.0	0.1416	0.03270	52.32

Again, 1 gm. of the matte was fused as above, the dissolved mass diluted to a litre, and for each determination 200 c.c. used. Tabulated we have:—

	C.c. taken.	Grms. ore.	C.c. Ag sol.	C.c. $\text{CNS}(\text{NH}_4)\text{ sol.}$	Grms. Ag to form Ag_3AsO_4	Grms. As.	P. ct. As.
1.	200	0.2	20	6.3	0.4513	0.10447	52.23
2.	200	0.2	20	6.2	0.4520	0.10463	52.31
3.	200	0.2	20	6.2	0.4520	0.10463	52.31
4.	200	0.2	20	6.1	0.4528	0.10482	52.41

Average = 52.30.

Two determinations were next made by precipitating the arsenic with magnesia mixture, moistening the precipitate with nitric acid, and glowing.

	Taken.	Found.
1.	200 c.c. = 0.2 gm.	0.2160 $\text{Mg}_2\text{As}_2\text{O}_7 = 0.10458 \text{ As} = 52.29$ per cent.
2.	200 c.c. = 0.2 gm.	0.2160 $\text{Mg}_2\text{As}_2\text{O}_7 = 0.10458 \text{ As} = 52.29$ per cent.

The results obtained volumetrically agree very remarkably with those obtained in the old way.

To test the method still further, a piece of speiskobalt from Schneeberg, in Saxony, was taken, finely powdered, and treated precisely as already indicated. I used 1 gm.

* It is just here that my method differs from that of Pearce and Low. They dissolve the precipitate in HNO_3 and determine the silver, while I obtain the silver in the filtrate and subtract it from the original amount added.

in this case, and diluted the solution of the fused mass to 1000 c.c. Six determinations were made volumetrically, 100 c.c. being taken each time. The remaining 400 c.c. were halved, and in each half the arsenic estimated by weight. Tabulated we have:—

	C.c. taken.	Grms. ore.	C.c. Ag sol.	C.c. CNS(NH ₄) sol.	Grms. Ag to form Ag ₃ AsO ₄	Grms. As.	P. ct. As.
1.	100	0.2	10	6.0	0.2036	0.04713	47.13
2.	100	0.2	10	6.0	0.2036	0.04713	47.13
3.	100	0.2	10	6.1	0.2028	0.04695	46.95
4.	100	0.2	10	6.0	0.2036	0.04713	47.13
5.	100	0.2	10	6.0	0.2036	0.04713	47.13
6.	100	0.2	10	6.0	0.2036	0.04713	47.13
Average = 47.10.							

Again:—

	C.c. taken.	Grms. ore.	Grms. Mg ₂ As ₂ O ₇	Grms. As.	Per cent. As.
1.	200	0.2	0.1945	0.0942	47.10
2.	200	0.2	0.1945	0.0942	47.10

The agreement with the mean of the volumetric results is perfect.

Before closing I would like to observe that I am endeavouring to discover the exact condition under which sulphide of arsenic may be so treated as to give a solution which may be tested as above described. Sulphide of arsenic, when oxidised with fuming nitric acid and then neutralised with potash, gives with nitrate of silver a precipitate which is not curdy but thick and muddy, and is sure to run through the filter. Excess of potassic nitrate added to the solution serves to check this disagreeable phenomenon, but not completely. I am inclined to attribute the anomaly to the excess of sulphuric acid present, generated by the action of the fuming nitric acid on the sulphur of the arsenic. By getting rid of the sulphate by means of barium nitrate this chasm may, I hope, be bridged over, and the method turn out as accurate as regards sulphide of arsenic as it has proved itself to be as regards arsenides.

John C. Green School of Science,
Princeton College, Princeton, New Jersey.
June 12th, 1883.

RECOGNITION OF GENUINE BEECH-WOOD CREOSOTE.

By H. HAGER.

PURE beech-wood tar creosote is not soluble in double its volume of anhydrous glycerin, but forms therewith a milky-white or whitish mixture, which ought not to be coloured. Other creosotes dissolve in double their volume of glycerin. To detect phenol, 3 vols. of a 75 per cent creosote are mixed with 1 vol. of the suspected creosote and well shaken. On settling there are formed two strata, a turbid one below and a lighter layer. The latter consists of the creosote which has given up its proportion of phenol to the lower stratum, its volume becoming smaller according to its proportion of phenol. In order fully to remove the latter (at least up to 98 per cent) from the creosote, the upper layer is again shaken up with three times its volume of 75 per cent of glycerin as before. On shaking up with ammonia at 5 per cent, the phenol passes into the latter, whilst the beech-tar creosote remains undissolved. If the sample is mixed with an equal volume of soda-lye at sp. gr. 1.334, it should form a clear yellow permanent liquid, a slight degree of heat being liberated. One vol. of beech-tar creosote dissolves completely and clearly in 2 vols. of petroleum benzine, and the solution should be almost colourless or yellowish. Creosote containing even 5 per cent phenol or cresol gives a turbid mixture. The solution of the creosote in petroleum

benzine is divided into three parts. The first is shaken up with an equal volume of liquid ammonia, the second with caustic soda-lye of sp. gr. 1.160. In neither should a dark colouration appear in the course of half an hour. The third portion is shaken up with an equal volume of baryta-water. No blue, violet, or red colour should appear in either stratum of the liquid. Such colours would indicate tar-constituents, which should not be present in creosote. If 1 vol. creosote is shaken up with 2 vols. of a 15 to 18 per cent. ammonia, a genuine pure sample takes, at most, a lemon-yellow colour in the course of half an hour, and the upper aqueous stratum is pale or yellowish. Equal volumes of creosote and collodion should form a mixture, which remains colourless for half an hour.—*Zeitschrift für Analyt. Chemie.*

NOTE RELATIVE TO BERYLLIUM.

By J. EMERSON REYNOLDS, M.D., F.R.S.

I REGRET to find that Professor Humpidge's "reply" to my recent "note" on beryllium is founded, in its only material part, on the assumption that a portion of a sentence which occurs in my paper is an unqualified statement, whereas, in fact, it is specially qualified in the preceding paragraph by these words, "there appears to be a considerable, *though irregular*, rise in the specific heat of the element (beryllium) as the proportion of impurity diminishes." This statement necessarily governs all that follow, and is in exact accordance with the facts. While it is obviously true that the specific heat value of beryllium was greater in the two purer specimens (Nilson's 94.4 per cent and Humpidge's 93.97 per cent) than in Nilson's first material (87.09 per cent), I specially point out that the rise in value noted is *irregular*, and in order to prove this irregularity, and at the same time to suggest caution in dealing with the "chameleon element," I used substantially the same data as those now given in Professor's Humpidge's "Reply." In other words, it is shown that the samples of *nearly equal* apparent purity agreed in giving higher specific heats than Nilson's 87.09 specimen, but that they differed considerably between themselves in the same particular.

The only material point in Professor Humpidge's "Reply" has, therefore, no real foundation, and to require more from me would logically amount to a request for an express statement that of two *different* values one is greater than the other!

I regret that the above correction of the "Reply" should be necessary, as a mere discussion about terms is unsatisfactory.

The Late Mr. Spottiswoode.—At the annual general meeting of the Society of Arts, held on Wednesday last, June 27th, the following resolution was passed:—"That this meeting of the Society of Arts desires to express the deep regret with which it has received the news of the death of Mr. William Spottiswoode, one of its Vice-Presidents, and its sense of the loss which the Society has sustained by his decease. In him, England loses one of her most remarkable men of science, science itself one of its greatest ornaments, and all who knew him a sincere and valued friend. Besides devoting his own time and thought to the advancement of knowledge, he was ever ready to lend to all engaged in like pursuits the assistance of his experience and his wise counsel. In thus placing on record their own appreciation of his services, the Society desires to express its feelings of sympathy with his widow and his family, and also with the Fellows of the Royal Society, of which he was the honoured and beloved President."

THE LATE MR. W. SPOTTISWOODE,
PRESIDENT OF THE ROYAL SOCIETY.

As these lines are passing through the press, the remains of the late President of the Royal Society are finding a fitting resting place in Westminster Abbey, followed by a body of mourners, representing the scientific and intellectual life of England. The sad loss that Science has suffered of one of its ablest supporters, and one who might in no small degree be held up as the ideal of a hard-working and conscientious searcher after truth for its own sake, will be keenly felt by the scientific men of this country, of whom he was such a brilliant representative.

Our old English system, which makes the *savant* a private gentleman instead of a State official, a salaried academician, or an emeritus professor, has many advantages; but it is unobjectionable only in the case of men whose time is entirely at their own disposal. In spite of his being harassed with the every-day cares connected with the management of the business of the Queen's printers, Mr. Spottiswoode has, since the day he left Oxford a graduate with many honours, found time to accomplish a mass of scientific work, which, from the depth and range of subjects treated, shows him to have been a man of the highest intellectual endowments, combined with an unbounded capacity for doing work. As an inquirer into nature, one of his most striking characteristics was thoroughness. No expenditure of time and labour seemed to him too great to bestow upon anything which he had undertaken.

Gifted with what was by no means a robust constitution, had Mr. Spottiswoode been more sparing of himself instead of devoting his whole mental and bodily energies to the performance of whatever business was before him, there is little doubt that Science would not have to mourn the irreparable loss it has just suffered.

Mr. Spottiswoode's warm sympathy with the work and aims of a numerous circle of scientific men in diverse fields rendered him a true friend and supporter, and his great powers as an administrator have been amply exhibited by the valuable services he has rendered to the British Association, the Mathematical Society, the Royal Institution, and at the Council Board of the Royal Society.

As President of the Royal Society, Mr. Spottiswoode united qualifications for this high position which are rarely met with in combination. He who in these days fills the chair of Newton must be not merely a *savant*, of whatever eminence, but also a man of the world and of society, capable of holding his own in the highest circles. He is the official representative of science in the eyes of Government. Hence he must be a diplomatist, combining with the utmost courtesy a firm determination not to compromise the interest, of which, for the time being, he is the embodiment. This is in England a position of peculiar difficulty from the ill-will and contempt with which science is often regarded by politicians of both parties.

In Mr. Spottiswoode none of the attributes required were wanting. One of the most prominent features in his character was his many-sidedness. Though mathematics and physics were his own especial province, yet his knowledge and his interest were confined to no one department. Various as are the papers read before the Royal Society, he always showed himself willing and able to follow them, and his brief but appreciative comment in proposing a vote of thanks to the author proved how fully he had seized upon the main points brought forward.

It is superfluous for us here to enumerate the various scientific subjects that have been enriched by Mr. Spottiswoode's active and fertile brain. As a mathematician he entered upon speculations which to the routine man of Science are a stumbling block,

and to the world at large foolishness, but which to the patient inquirer are signally suggestive. What if the poly-dimensional space thus conceivable by the mathematician really exists, and if the tri-dimensional character which we recognise in solids has its ground merely in the limitations of our own being? We must beware of rashly concluding that the speculations of such men as Spottiswoode and Clifford are mere exercises of analytical subtlety which can never bear fruit. For the most part his investigations are addressed to the mathematical student, and are draped in symbols intelligible only to the professed mathematician. In late years, however, Mr. Spottiswoode turned his abilities to the study of experimental physics, and as the result has contributed several important papers to the *Philosophical Transactions* and the *Proceedings of the Royal Society* on the "Polarisation of Light and on Stratified Discharges through Rarefied Gases."

In some quarters it has been hinted that Mr. Spottiswoode was a mere amateur. We do not quite know the meaning of this word as applied to a man of science, but if it is intended to convey the impression that he was only superficially acquainted with the many subjects on which he thought and wrote, nothing could be wider of the mark. Whatever subject Mr. Spottiswoode turned his mind to he "took the heart out" of it. His researches, though occasioning no controversies and being utterly free from anything of a sensational character, are eminently fertile, and what the Germans call *bahn-brechend*, opening out tracks to new regions of discovery.

ELECTROLYSIS OF BISMUTH SOLUTIONS.

By N. WILEY THOMAS and EDGAR F. SMITH.

In estimating bismuth in the electrolytic way, solutions of the sulphate, alkali solutions of the citrate, and the latter in presence of free citric acid were used.

I. A weighed quantity of bismuthous oxide was dissolved in about 1 c.c. conc. sulphuric acid and then diluted to 100 c.c. with distilled water. 10 c.c. of this solution contained 0.0358 grm. metallic bismuth. In two experiments with this solution 10 c.c. of the same were placed in a small platinum crucible surrounded by a stout copper wire leading from the zinc pole of a three (one quart) celled bichromatic battery. Into the solution dipped a platinum wire connected with the carbon pole. The current ran three hours, was then interrupted, and the liquid quickly removed from the vessel. The deposited metallic bismuth, compact and perfectly regular, was washed first with water, then with alcohol, after which it was dried and weighed.

Found, *a*, 0.0354 grm. Bi; *b*, 0.0358. Required, 0.0358 grm. Bi.

In two additional experiments, instead of placing the bismuth solution in a crucible it was put into a beaker glass, diluted up to 100 c.c. with water, and a platinum crucible connected with the zinc pole was suspended in the liquid. The platinum wire from the carbon pole extended down below the crucible. The solution being so much more dilute than in *a* and *b*, the current was allowed to run five hours before being interrupted. The crucible, upon the outside of which the metal had deposited in a homogeneous form, was then removed, the coating washed as before, dried, and weighed.

Found, *c*, 0.0310 grm. Bi; *d*, 0.0355. Required, 0.0358

The liquid remaining from *c* gave a brownish colouration with hydrogen sulphide.

This method can be employed with satisfactory results by using moderately concentrated solutions and having

the wire from the carbon pole not too far removed from the vessel upon which the metal is to be deposited.

II. Bismuth hydrate was dissolved in conc. citric acid and the liquid then made alkaline with sodium hydrate. The quantity of metal in solution was determined and definite portions of the liquid then electrolysed.

Found, 1, 0.0356; 2, 0.0358; 3, 0.0358. Required, 0.0356.

The slight difference is probably due to the difficulty experienced in removing the alkali and to errors in weighing. Only two of the previously mentioned cells were used. The time allowed for the precipitation was three hours. The deposit in each case was compact and regular.

III. An alkaline citrate solution of bismuth was acidified with citric acid and definite portions of it subjected to the action of the current. Two cells were employed and the average time for precipitation was two and a half hours. Required Bi=0.0356 grm; found:

1.—0.0358	7.—0.0357
2.—0.0353	8.—0.0356
3.—0.0352	9.—0.0357
4.—0.0358	10.—0.0358
5.—0.0356	11.—0.0358
6.—0.0358	12.—0.0356

Heat does not hasten the precipitation. In some instances when the current was not very brisk a slight deposition of oxide upon the wire was observed, but this invariably disappeared before the action of the current was interrupted.—*American Chemical Journal*.

PROCEEDINGS OF SOCIETIES.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, Monday, July 2, 1883.

Sir FREDERICK POLLOCK, Bart., M.A., Manager and Vice-President, in the Chair.

J. G. Crawford and Gustavus Steinthal were elected Members of the Royal Institution.

The decease of Mr. William Spottiswoode, P.R.S., Manager and Vice-President of the Royal Institution, on the 27th June last, was announced from the Chair, to the deep regret of all the Members present.

The presents received since the last meeting were laid on the table, and the thanks of the Members returned for the same.

CORRESPONDENCE.

BROMINE WATER AS A TEST FOR STRYCHNINE.

To the Editor of the Chemical News.

SIR,—Professor Bloxam has asked me to communicate to you the following additional information with regard to the use of bromine water as a test for strychnine.

Having experienced a slight difficulty in obtaining the violet colour by proceeding according to the directions given in his article (*CHEMICAL NEWS*, vol. xlvii., p. 215), I found it an advantage to render the solution considerably

acid, by adding a few drops of concentrated hydrochloric acid, and to boil before adding the bromine water. In this way the colour is produced more quickly, and is of a very much deeper shade, approaching, in a solution containing 1 per cent of strychnine, to the colour of a strong solution of cobalt nitrate.

The test is rather more delicate if a few drops of strong sulphuric acid be substituted for the hydrochloric acid, whenever it is practicable.

I have determined the delicacy of the test when applied as directed above. I find that a faint but perfectly distinct rose-pink is obtained in a solution containing 1-2000th of a grain of strychnine.

The colour increases in intensity directly as the strength of the solution of strychnine, and is quite permanent. The following experiment points to a valuable method for the quantitative estimation of strychnine by colour:—

A 1 per cent solution of strychnine was coloured to its maximum intensity by bromine water, and then diluted until the solution contained 0.1 per cent of strychnine.

A 0.1 per cent solution of strychnine was coloured to its maximum intensity by bromine water. The colour produced was identical with that of the diluted 1 per cent solution.

I would suggest that a coloured solution of strychnine of known strength should be taken as a standard, and the determination made in a way analogous to that for the determination of ammonia by Nessler solution.—I am, &c..

HERBERT JACKSON.

King's College, London, July 3, 1883.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvi., No. 24, June 11, 1883.

Separation of Gallium.—Lecoq de Boisbaudran.—Inserted in full.

Facts and Results serving for the Demonstration of Novel Properties.—M. Rohart.—Ferric sulphate, as neutral as is chemically possible, can form perfectly definite and very stable compounds with animal matters and the extractive principles of plants. It precipitates them from their solutions and preserves them from being re-dissolved or from being decomposed by the action of air. [The author's results, though not novel to chemists who have carefully studied the sewage question, may prove instructive to those who still maintain that dissolved organic matter cannot be precipitated by metallic salts.—Ed. C.N.]

Researches on Phosphoric Class.—M. Sidot.—This glass, which is not attacked by hydrofluoric acid (*Comptes Rendus*, June 25, 1877), is now produced on the large scale.

Variation of the Capillary Constant of Surface of Ether Water and Carbon Disulphide Water under the Action of an Electromotive Force.—M. Krouchkoll.—The author has remarked that insulating liquids, such as carbon disulphide, ether, oil of turpentine, not miscible with water, when in contact with the latter liquid, acquire a decided conductivity, easily recognised by means of a Lippmann's electrometer. Further experiments proved that the capillary constant of the surfaces of water-ether, &c., vary under the action of an electromotive force in the same manner as that of a surface of water-mercury.

Formation of Bibasic Sodium Glycolate.—M. de Forcrand.—A thermo-chemical study.

Hydrates of Baryta.—E. J. Maumené.—The author maintains that hydrates with a single molecule of water are exceptional. The hydrate obtained by crystallisation in water has been repeatedly examined. Filhol gives it as containing 8 mols. of water, whilst Lescœur makes it 9 mols. The author finds 8.5 mols. The hydrate melted at a red heat contains 1.214 mols., whilst an intermediate compound contains 2.83.

Artificial Reproduction of Barytine, Celestine, and Anhydrite.—A. Gorgeu.—The author obtains these compounds by means of the solvent action of melted metallic chlorides upon the alkaline earthy sulphates.

No. 25, June 18, 1883.

Phosphorus Sulphides.—M. Isambart.—The author, whilst admitting the priority of M. Lemoine as regards certain facts brought forward in his paper of May 21st, points out that the conclusions respectively arrived at are not identical. M. Lemoine does not recognise the difference between the liquid sub-sulphide formed by mixing sulphur and phosphorus at 100°, and the sub-sulphide which has been exposed to a temperature higher than 130°.

Certain Properties of Tin Sulphide, Selenide, and Telluride.—A. Ditte.—Pure tin mono-sulphide is a brilliant substance, of a bluish metallic lustre, like that of galena; it is soft and friable, and its dust soils the fingers. Its formation is effected without notable liberation of heat, and its vapour is dissociated under the influence of heat. Its sp. gr. at 0° is 5.0802. Tin selenide is formed with a notable disengagement of heat and light. In its physical properties it much resembles the sulphide. Even at high temperatures it suffers very slight decomposition. Its sp. gr. at 0° is 6.179. Tin telluride is formed with a disengagement of light. It is not decomposed by the action of heat. It is of a greyish white colour and metallic lustre. Its sp. gr. at 0° is 6.478.

Determination of Carbonic Acid in the Air at the Stations of Observation of the Passage of Venus.—A. Muntz and E. Aubin.—The quantities observed are sometimes sensibly lower than those registered in France and Germany, and the maxima do not rise above ours. The general mean is 2.78, which is a little lower than that found by M. Reiset in the north of France (2.962), and the author's determinations in the plain of Vincennes (2.84), and on the summit of the Pic du Midi (2.86). The mean for the night (2.82) is slightly above the general mean.

Volumetric Determination of Carbon Disulphide in the Sulpho-carbonates.—E. Falières.—This paper, with the accompanying tables, do not admit of useful abstraction.

Emetics of Mucic Acid.—D. Klein.—[The term "emetics" is here applied generally to compounds considered analogous to antimony-potassium tartrate.] Mucic acid, like tartaric acid, belongs to the class of acids of mixed functions: it is an acid alcohol, and therefore, like tartaric acid, it forms true emetics. The author has obtained potassium and sodium boro-mucates, which are amorphous masses, very soluble, and closely resembling the potassium boro-tartrate; also an ammonium antimony mucate, and the corresponding potassium and sodium compounds.

Journal de Pharmacie et de Chimie.
Tome vii., June, 1883.

Action of Sulphur on the Oxides.—MM. Filhol and Senderens.—A thermo-chemical study of the behaviour of sulphur with potassa and soda, both in the solid state and in solutions more or less dilute. If potassa or soda is ground in a mortar with excess of sulphur there is obtained in a few moments a mixture of polysulphide and of

hyposulphite. The action of sulphur upon dissolved alkalis becomes less and less easy as the solution is more dilute.

Modification of the Hydrotimetric Method.—L. Garnier.—The author finds that the alcoholic solution of soap used in determining the hardness of water often deposits a portion of its soap, which does not readily redissolve. To save time he proposes to filter, to re-standardise with calcium chloride or barium nitrate, and to calculate the results accordingly.

Researches relative to the Action of Zinc-Ethyl upon the Amines and Phosphines.—M. H. Gal.

Cosmos Les Mondes.

Tome v., No. 7, June 16, 1883.

Nitro-hydrochloric acid is coming into use in Italy as an antiseptic and ferment destroyer. For rendering suspicious waters potable it is recommended in the proportion of one part in 200 (2000?)

A new colour (*vinoline*) has been invented for the sophistication of wine. If boiled with sodium hyposulphite, the characteristic odour of nitro-benzol is developed. It is detected in wines by treatment with lime or baryta-water. A genuine wine takes a green tint, whilst if vinoline is present the red colour is merely darkened.

Archives Neerlandaises des Sciences Exactes et Naturelles,
Tome xviii., Part 2.

This issue contains no chemical or physical matter.

Bulletin de la Société Chimique de Paris.
No. 9, May 5, 1883.

The only original paper in this issue is a minute description of the production of the so-called Sèvres blue upon porcelain, furnished by M. Ch. Lauth.

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THE CHEMICAL NEWS.

VOL. XLVIII. No. 1233.

METHODS OF ANALYSING SAMARSKITE

AND THE OTHER COLUMBATES CONTAINING EARTHY OXIDES, BY THE AGENCY OF FLUORHYDRIC ACID; AND OF DISSOLVING COLUMBITE AND TANTALITE BY THE SAME ACID.—ON THE SEPARATION OF THORIA FROM THE OTHER OXIDES.—QUANTITATIVE ESTIMATION OF DIDYMIUM OXIDE IN ITS MIXTURES WITH OTHER EARTHY OXIDES.

By J. LAWRENCE SMITH, Louisville, Ky.

The study of this class of minerals has always presented considerable interest to the analytical chemist, from the time of the discovery of columbite by Hatchett in 1801, and tantalite and yttritanalite by Ekeberg about one year later. These minerals for more than twenty years were the only known columbites and tantalites; since then about fourteen other well-defined species have been discovered and described, although the chemical formulæ of most of them are yet in doubt.

The metallic acids in these minerals have many interesting characteristics, which have already attracted special attention since H. Rose's researches in 1846 defining the distinctive characteristics of columbic and tantallic acid, which, prior to that date, had been considered by most chemists as being one and the same acid. M. Hermann, and later, M. Marignac, took up M. Rose's investigations, and gave to them considerable extension. The former thinks that he has discovered two additional metallic acids of the same type in the minerals in which the first two are found. The metals of these acids he has called ilminium and neptunium.* The labours of M. Marignac, as set forth in his various publications,† have contributed very largely to our precise knowledge of certain very important compounds of these acids, and he has also given the only reliable method of a close quantitative separation of columbic and tantallic acid.

An interesting chemical characteristic of these minerals is that nearly all of them have, as a portion of their bases, some one or more of the rarer earths, as the oxides of yttrium, erbium, cerium, thorium, and some new earths not yet fully defined. One reason for the comparatively imperfect study of the compounds of tantalum and columbium is the rarity of the minerals containing them; but since the discovery of comparatively large quantities of columbite and samarskite in the United States this difficulty is removed. Another obstacle to their study arises from the method of decomposing them, this being attended with more or less inconvenience when large quantities are to be operated on. This last difficulty will, however, be removed to a considerable extent by the analytical facts to be detailed in this communication.

In my published investigations in connection with the columbic and tantallic acid minerals from new localities in the United States‡ (more especially the remarkable developments of samarskite in North Carolina), the object in view was to detail all that was connected with their mineralogy, to describe the new species I had discovered, and to give a clear idea of their constitution in comparison with the same minerals as found elsewhere. In the analyses in that paper I did not give the relative proportions of columbic and tantallic acids, assigning as my reason at the time for this omission that the method I had worked

with (Rose's) proved too unsatisfactory to warrant the waste of time in seeking after results that I was satisfied would be inaccurate. In this view I was sustained by M. Marignac, who has devised a much better method, which I have since tried, and which gives very good approximate results, within 1½ to 3 per cent, according to the amount of tantallic acid present. In the same paper I stated that the earths in samarskite did not appear to contain cerium oxide as does the Ural variety of the same mineral, although in the analyses then given I preferred noting the earths of that group as cerium oxides* until I could arrive at more satisfactory conclusions by renewed researches; for it is known that a small quantity of cerium oxide mixed with other oxides of that group may escape detection when the entire amount of oxides treated is very small; so it was thought better to repeat the experiments on larger quantities before making any conclusive statement as to the presence or absence of cerium oxide. Thoria, also, if present in the North Carolina samarskite, was there in too minute a quantity to warrant me in pronouncing upon it by the usual method of separation. All doubt, however, on this head has been dispelled by an easy and certain method I have discovered of separating it from the other earths, and, although present in the proportion of less than 1 per cent in the mineral, it can be separated and identified as well as any other constituent of the mineral, and that by operating with not more than three or four grammes of the mineral.

Method of Decomposing and Analysing Samarskite.

I shall first detail the method pursued in the analyses of samarskite, as this being one of the most complex of the columbates, all that is said in regard to it will be applicable to other forms of this class of natural compounds. The method most commonly employed for decomposing this mineral is by means of potassium bisulphate in the proportion of one part of mineral to six of potassium salt. This, it will be seen, introduces a very large amount of solid matter into the process, and, besides, requires careful heating to redness for some time. A more recent and better method is that proposed by Prof. Wolcott Gibbs,† viz., by the acid potassium fluoride (FKFHO). This method was used by M. Marignac in his most admirable and exhaustive labours on tantallic and columbic acid compounds already referred to. Concentrated sulphuric acid when heated with some of the columbates will decompose them more or less, but cannot be used in their analysis. The method about to be described is a decided improvement on either of the above, for reasons that will be rendered very apparent.

Decomposition by Fluorhydric Acid.‡

The quantity of samarskite used in the analyses is usually five grammes, and having an abundance of the material, special portions are used for the verification of certain results. The precipitates of all the ingredients are so dense and granular that filters 7 to 10 c.m. in diameter are used except in the iron precipitate. The mineral is triturated to a fine powder, and 5 grammes, dried at 150°

* By this group is meant all the oxides forming insoluble double salts with the potash and soda sulphates, amounting to about 4 per cent of the mineral. Thoria, if present, was to be sought for among the oxides.

† *American Journal of Science*, xxxvii., 355.

‡ Not many years ago this acid was made and used in comparatively small quantities, but owing to the extended use of it in the arts, it is now manufactured on a large scale. One of the largest manufacturers of this acid in America is Feuchwanger, 118, Dey Street, New York, who furnishes a *fuming acid*, remarkably pure for a commercial article, at 25 cents per pound, in lead jugs of 30 lbs. capacity. The saturating property of 10 grammes of this acid is equal to that of 23 grammes of nitric acid of 1.42, costing 12 to 14 cents by the carboy, making the fluorhydric acid actually cheaper than the nitric acid. I have found in many laboratories what purports to be fluo. hydric acid that is little less than sour water. When I desire pure fluorhydric acid, I distil the commercial acid of Feuchwanger in a small platinum still and condense in a very little distilled water, the vessel being surrounded by ice. In this way there is no annoyance from fluor-silicic acid.

* *Jour. f. Prak. Chem.*, xv., 103. Chemists are not ready to recognize these as new substances, but rather as mixtures of tantallic and columbic acids.

† *Annales de Chim. et de Phys.*, viii., 1866, 115-75.

‡ *American Journal of Science*, May, 1877, 360.

C,* weighed and placed in a small platinum capsule; one of 50 c.c. capacity is sufficiently large. This is moistened with about 5 or 6 c.c. of water, and then from 8 to 10 c.c. of concentrated fluorhydric acid is added (one-half at a time with an interval of two or three minutes), and the mixture stirred with a platinum rod. In a few seconds a vigorous action takes place: the mass becomes heated, and in from five to ten minutes the decomposition is complete without the application of heat. If the powder be exceedingly fine the decomposition is almost as rapid as that of calc-spar when chlorhydric acid is poured upon it.

The action is known to be complete by the disappearance of every black particle in the mass. The capsule is now placed on the water-bath to ensure complete decomposition and to evaporate away the larger portion of the liquid.

After the reaction the contents of the capsule are, 1st, a clear colourless solution; and, 2nd, a heavy green precipitate. The solution contains all the metallic acids, oxides of iron and manganese. The insoluble portion contains all the earths and uranium oxide. It is true that traces of iron will be subsequently found in the analysis of the insoluble part and traces of earth in the solution, but they are easily separated in the course of the analysis and properly placed in the estimates. They, however, only represent a fraction of 1 per cent.

It will be seen that thus far in a very few minutes the samarskite has not only been decomposed but partly analysed, for this perfect separation into two parts facilitates to a vast extent the subsequent operations.

To the contents of the capsule, decomposed as above stated, 30 c.c. of water are added; the whole is then warmed and thrown on a filter (8 c.m.) in a gutta-percha or silver funnel, the filtrate being received in a platinum capsule. The filtration takes place very rapidly, and the precipitate is well washed with hot water, a few drops of fluorhydric acid being added towards the end of the washing, to prevent a trace of the precipitate passing through the filter, which might otherwise occur. The filtering and washing is accomplished in fifteen or twenty minutes. As already stated, we have two classes of substances completely separated from each other, one soluble, the other insoluble. The soluble we call A, the insoluble we call B.

We will first consider A. This solution is evaporated over a water-bath, and before it reaches dryness concentrated sulphuric acid is added in excess to decompose the fluorides, about 1 c.c. acid to every gramme of metallic acid supposed to be present. The evaporation is completed by careful heating over the flame until the decomposition is complete and nearly all the sulphuric acid has been driven off. After cooling, water is added acidulated with chlorhydric acid, and the contents of the capsule washed out into a glass flask capable of holding one litre. When 5 grammes of the mineral have been used the liquid mass should be half a litre. A little chlorhydric acid is added. This is now boiled for one or two hours,† which can be done in an ordinary bottle.

After boiling, the contents of the vessel are thrown on a filter and thoroughly washed with hot water. The insoluble part remaining in the filter is columbic and tantalic acids with a little tungstic and stannic acid. This is dried, ignited, and weighed with all the usual precautions, and afterwards the tungstic and stannic acids are separated in the manner described by Rose, and the columbic and tantalic acids by Marignac's method.‡

The filtrate from the metallic acids is concentrated, and as it contains only iron and manganese, with mere traces

of other oxides, they are separated and estimated in the usual way by the sodium acetate method. This disposes of part A. We now pass to the portion B, which is the insoluble part remaining after the first treatment with fluorhydric acid, and is composed of the fluorides of the earths and uranium. It is washed from the filter into a small platinum capsule. To this sufficient concentrated sulphuric acid is added to decompose the fluorides (about 2½ grammes suffice where 5 grammes of minerals are used), and the whole is concentrated as far as possible over a water-bath, and carefully heated over the flame until the excess of sulphuric acid is driven off, or very nearly so. After cooling, about 50 c.c. of water are added, and the capsule is gently heated on a water-bath, when the mass dissolves completely, furnishing a bright green solution. A minute amount of insoluble matter may sometimes show itself; this belongs to the metallic acid, and is separated and added to that obtained from A. It is usually only a few milligrams. The green solution is heated over the flame, and a little nitric acid is added, when the colour is changed to a lemon-yellow, from the higher oxidation of the uranium oxide. The solution is now introduced into a beaker, and increased to about 250 c.c. by the addition of water, and made to boil. It is then very nearly neutralised by ammonia, and oxalic acid or ammonium oxalate added very gradually. The precipitate, as is well known, will be first taken up and afterward become permanent. It consists of all the earths present. This is allowed to stand some six or eight hours, then thrown on a filter, and well washed. This oxalate of the earths I will call C, and proceed to treat of it a little further on. The filtrate contains all the uranium in solution with a trace of iron. This is concentrated to about 80 or 100 c.c., and then a concentrated solution of ammonium carbonate is added, which first precipitates the uranium oxide and then re-dissolves it. The solution is nearly clear with the exception of a few floccs of ferric oxide. This is warmed gently, and a few drops of ammonium sulphide are added, which precipitates every trace of iron. That is washed and estimated in the usual way, and represents from two to three-tenths of one per cent of the mineral, and is added to the ferric oxide obtained from solution A. The filtrate containing the uranium oxide is evaporated to dryness, the ammonium salts driven off, and the oxide estimated by the ordinary method. In all the analyses thus far no solid matter is introduced by the reagents.

Before quitting this part of the subject I would state that there is no columbate that does not readily yield to this treatment by fluorhydric acid, as euximite, hatchettolite, fergusonite, &c., and so completely separate these minerals into two classes of substances (the metallic acids in a state of solution and the earths as insoluble compounds), that the weighing of the acid decomposed by the action of sulphuric acid as described will give at once an idea of the quantitative composition of the minerals.

Columbite and Tantalite.

It is well to make some remarks in reference to the columbite and tantalite and their decomposition by fluorhydric acid, for they are more difficult to decompose by any method than are the columbites of the earths.

Before we had the more powerful and convenient methods of decomposing minerals, Berzelius, Rose, and others had to resort to the finest possible sub-division of the mineral, often using a flat slab of agate and triturating with water. This fine trituration is sometimes, even now, employed in our present modes of manipulation. As the method I have adopted for years is more convenient than any I know of in use, it will not be out of place to refer to it here, for the whole operation is conducted in the same mortar in which the crushed mineral is first powdered.

If we have columbite to decompose, exceedingly fine dry trituration in an agate mortar suffices. To triturate properly, one gramme of columbite will require from ten to fifteen minutes in a 4-inch mortar. Thus pulverised, place the mineral in a platinum crucible or capsule, and

* Avoid heating to redness, for by so doing the mineral is not so readily acted on by the fluorhydric acid. I determine the loss by heat on a separate portion of 1 gramme.

† In my laboratory the boiling of liquids containing a heavy precipitate is always accomplished by driving steam through from a glass flask or small boiler, with two tubes, one bent at two right angles to drop in the liquid, and the other a straight one for a safety tube, thus preventing all thumping.

‡ *Annales de Chim. et le Physique*, viii., 1866, 115-175.

add about 5 grammes of fluorhydric acid of the strength alluded to in the first part of the paper; then heat over the flame on a plate of iron, so as to bring the temperature up to from 60° to 90° C. Half-an-hour suffices for complete solution; if any black powder remains, it is well to add a little more acid and heat again. A few flocci will sometimes appear in the solution, which is stannic oxide. In the analysis of tantalite the solution is not so easily accomplished, but I overcome that completely by my modification of the trituration of the mineral. After rubbing it up in the mortar for about five or six minutes, I add a little strong commercial (95 per cent) or absolute alcohol to the contents of the mortar, enough to cover completely the powder, then continue the trituration. The alcohol will soon evaporate; add a fresh portion; this I may have to repeat several times. The alcohol, like any other liquid, enables the pestle to reach thoroughly the coarser particles that always settle to the bottom. To triturate thoroughly, 1 gramme of the tantalite requires about twenty minutes. The contents of the mortar are like imperfectly-dried mud, and are kept at a temperature of about 150° C. in an air-bath for ten or fifteen minutes. A gramme of the material is then placed in a capsule or crucible of platinum, thoroughly dried, and carefully weighed. About 5 grammes of the fluorhydric acid are now added, and the heating conducted as in the case of columbite. Half-an-hour suffices to complete the solution, which is a clear liquid with a few white flocci in it that I have proved to be stannic oxide. While this method of solution appears to be a little tedious, I can assure those who try it that the manipulations are very simple, and there is no soluble matter introduced, as is the case when six or eight times its weight of potassium bisulphate is used. We now evaporate the solution of either columbite or tantalite to dryness; proceed as in the case of the samarskite. As there are no earths, however, in these minerals, there is little else than iron and manganese to deal with as associated with the metallic acids, which are decomposed by sulphuric for separation from iron and manganese as already indicated.

In regard to the separation of the two acids when they are in the same mineral, I use the method already referred to and first used by Marignac.*

The tungstic acid, stannic acid, &c., I estimate in the manner pointed out by Rose in his "Analytical Chemistry."

(To be continued.)

SEPARATION OF GALLIUM.

By M. LECOQ DE BOISBAUDRAN.

Separation from Ruthenium.—Good results are obtained by means of the three following processes, the first of which is the most advantageous. The ruthenium should be in the state of sesquichloride.

1. The solution, strongly acidified by hydrochloric acid, is saturated with sulphuretted hydrogen, and then heated to a boil, which is kept up for fifteen to twenty minutes. A current of hydrogen sulphide is passed through the liquid all the time of the heating, and until it is cold. The ruthenium sulphide, collected upon a filter, is washed with sulphuretted hydrogen water, acidulated with hydrochloric acid. The evaporation of the filtrate gives gallium chloride.

2. The mixture is precipitated in heat with a small excess of caustic potassa, and the alkaline liquid is kept for some time in ebullition. The ruthenium oxide filtered off retains a little gallium. It is therefore re-dissolved in hydrochloric acid, and re-precipitated with potassa. Three or four treatments of this kind ordinarily suffice to eliminate the gallium, which is finally entirely contained in an

alkaline solution, whence it is easily extracted by means of cupric hydrate.

3. Potassium ferrocyanide precipitates gallium very well in presence of ruthenium sesquichloride. The solution should be cold, and should contain one-fourth to one-third of its volume of hydrochloric acid. The gallium ferrocyanide is carefully washed with water strongly acidified with hydrochloric acid. If the ruthenium and gallium occur in a compound insoluble in hydrochloric acid, or in aqua regia, the substance is put in a gold crucible and attacked with a mixture of potassa and nitre at a dull red-heat. The aqueous solution of the resulting mass is treated with an excess of hydrochloric acid, and heated to boiling. The ruthenium exists as sesquichloride in the liquid thus obtained, and is separated by one of the processes above described.

Separation from Osmium.—The method given is exact, and is applicable to solutions containing either osmic acid or osmium chloride. The liquid is strongly acidified with hydrochloric acid, and is treated in the cold with a current of hydrogen sulphide; the temperature is then slowly raised to near ebullition, at which it is kept for about an hour, still continuing to pass the sulphuretted hydrogen. The filtrate, being saturated in the cold with hydrogen sulphide, and then raised to a boil, should not take a brown colour, which would show an incomplete precipitation of the osmium. There still remain, however, some slight traces of osmium in the colourless liquid. It is therefore well to pass sulphuretted hydrogen slowly through the liquid during its concentration. When the acid solution is reduced to a very small bulk there is added a little sulphuretted hydrogen water, and the mixture is boiled for a few minutes. A very small quantity of osmium sulphide is separated, and must be added to the bulk of the same compound previously obtained.

Separation from Arsenic.—In a strong hydrochloric solution hydrogen sulphide precipitates the arsenic entirely, whilst all the gallium remains in solution. The arsenic sulphide is washed with water acidified with hydrochloric acid, and not with pure water, to prevent the precipitate from passing through the filter.

Separation from Selenium.—According to circumstances one of the two following processes may be employed. The selenium should be present in the state of selenious acid.

a. The solution, rendered distinctly acid with hydrochloric acid, is treated with a current of hydrogen sulphide, whilst the temperature of the solution is gradually raised to a boil. The selenium sulphide is collected on a filter, and the filtrate yields gallium chloride on evaporation.

b. The liquid is acidified by hydrochloric acid, and the selenium is reduced by means of a current of sulphurous acid passed through the hot solution. The liquid is kept at a boil for ten to fifteen minutes, which agglomerates the selenium and prevents it from passing through the pores of the filter. The gallium is found in the filtrate.

—*Comptes Rendus.*

ON SCOVILLITE, A NEW PHOSPHATE OF DIDYMIUM, YTTRIUM, AND OTHER RARE EARTHS, FROM SALISBURY, CONN.

By GEORGE J. BRUSH and SAMUEL L. PENFIELD.

IN October last Mr. Joseph S. Adam, formerly an assistant in the Sheffield Laboratory, but now chemist of the iron furnaces at Lime Rock, Conn., sent one of us a mineral he had discovered occurring sparingly as an incrustation on some of the iron and manganese ores from the Scoville ore bed in Salisbury, Conn. Mr. Adam found the mineral to be a hydrous phosphate, and sent it to us for further identification.

* *Ann de Chim. et d. Phys.*, viii., 60. 1866.

The specimens which Mr. Adam kindly furnished us for examination show the mineral incrusting limonite and pyrolusite, very much as gibbsite coats the limonite of the Richmond ore bed. The incrustation is one-sixteenth of an inch or less in thickness, and is frequently botryoidal or stalactitic in form. On the cross fracture it presents a radiated fibrous structure. The colour is of a pinkish, brownish, to yellowish white. It has a silky to vitreous lustre on the fracture, but the natural surfaces have a greasy look, and in lustre and colour, as well as in form of occurrence, the mineral resembles some varieties of chalcedony or smithsonite. Hardness = 3.5. Sp. gr. 3.94 to 4.01.

The preliminary examination proved the mineral to be an infusible hydrous phosphate, affording no colouration when treated with cobalt solution, but when fused with salt of phosphorus and borax it gave a remarkable rose-coloured bead, both in the oxidising and reducing flames. The mineral is soluble in hydrochloric and nitric acids. Qualitative analysis showed it to be essentially a hydrous phosphate of the cerium and yttrium metals, with a trace of iron and a small amount of carbonic acid. As so few minerals contain these rare earths, and the methods for their separation and determination are frequently attended with difficulty and uncertainty, we have thought proper to give in detail the methods employed in the analyses.

The mineral was dissolved in hydrochloric acid, and the metals were precipitated from the acid solution as oxalates. The oxides obtained from igniting this precipitate were easily soluble in dilute acids, giving light rose-coloured solutions, from which, on addition of a solution of potassium sulphate, a precipitate of the sulphates of the cerium metals was separated. This precipitate, first freed from all traces of the yttrium metals, gave no reaction for cerium when tested by Gibbs's method* with peroxide of lead, but solutions of the oxides examined with the spectroscope showed the absorption bands characteristic of didymium. An acetic solution of the oxides was supersaturated with ammonia, and the precipitate which was formed was filtered off and thoroughly washed: this precipitate, when sprinkled with iodine, gave the characteristic blue colouration due to the presence of lanthanum.†

In the filtrate from the precipitated sulphates of the cerium metals, the yttrium metals were thrown down as oxalates from hot acid solutions. The precipitate had a faint pink colour, and when ignited and dissolved in acid the solution showed with the spectroscope the erbium absorption bands. The spark spectrum showed that yttrium was also present.

In the quantitative analyses, owing to the scarcity of pure material, the separate determinations were made on small quantities so as to give chances for repetition or variations in the method if necessary. The analyses were made on the air-dried mineral. It was found that the powdered mineral lost water, but it soon assumed a constant weight when dried at 100° C. The mineral dried at 100°, and then ignited in a Bohemian glass tube, gave the more firmly combined water which was collected in a chloride of calcium tube and weighed. Carbonic acid was determined by dissolving the mineral in a flask with dilute hydrochloric acid, and collecting and weighing the liberated gas in potash bulbs. In analysis II. the mineral, after drying at 100°, was directly ignited over the blast lamp, giving a loss of water and carbonic acid agreeing closely with the sum of the separate determinations in analyses I. and III. One direct determination of phosphoric acid was made with ammonium molybdate (analysis IV.). After filtering off the phosphorus precipitate the bases were precipitated from the filtrate by means of ammonia, and after the separation of traces of molybdenum and the cerium metals a volumetric determination of iron was obtained.

For the separation of phosphoric acid from the bases

the following method was adopted:—The mineral being easily soluble in hydrochloric acid, a solution containing little free acid was obtained; this was poured into about 500 c.c. of boiling water containing enough ammonium oxalate in solution to unite with the bases to form oxalates; the separation of a crystalline precipitate of the oxalates soon took place, which was quite free from phosphoric acid, and contained all but traces of the bases: the solution and precipitate were allowed to stand over night, then filtered and washed with hot water. The filtrate was evaporated to small bulk, and the remaining oxide precipitated along with some phosphoric acid from the hot solution by means of ammonia. This small precipitate was collected and weighed, and the oxides separated from the phosphoric acid by means of mercurous nitrate.* From the filtrates the phosphoric acid was precipitated with magnesia mixture. The precipitates of the oxalates were brought together, strongly ignited over the blast lamp, and weighed. After weighing they were dissolved in sulphuric acid, and to the solution enough hot concentrated potassium sulphate solution was added to give when cold a saturated solution, and thus cause the precipitation of the lanthanum and didymium. These metals were not separated, but an attempt was made to determine the quantity of the didymium by igniting the nitrates obtained from a weighed quantity of the oxides in a current of oxygen, which should give, according to B. Brauner,† the higher oxide of didymium, Di_2O_5 and La_2O_3 , and from the gain in weight of the oxide it was hoped that the quantity of didymium could be calculated. The results, however, were unsatisfactory, the gain in four trials being 7.5, 8.6, 6.9, and 8.2 per cent of the oxide employed. Pure didymium oxide with atomic weight 146.58 would require an increase of 9.38 per cent. A determination of the combined atomic weight of these oxides, made by converting a known weight of oxide into anhydrous sulphate, gave 142.6, which was the number used in calculating the results of the analyses.

The filtrate from the precipitated sulphates of the cerium metals was treated with ammonium oxalate to separate the yttrium metals. The precipitate of the latter being impure, it was in all cases re-dissolved and re-precipitated, and after ignition weighed as oxides. No attempt was made to separate the yttrium from the erbium. A determination of the combined atomic weight of the two oxides, made by converting a known weight of oxide into anhydrous sulphide, gave 115, indicating that the proportion of yttrium is about twice that of the erbium. Analyses I., II., III., and IV. were made on about 5 grammes; analysis V. on about a gramme. The results are as follows:—

	I.	II.	III.	IV.	V.	Mean.	Ratio.
P_2O_5 —	—	24.96	25.03	25.00	24.77	24.94	0.1756
$(\text{Y}_2\text{O}_3, \text{Er}_2\text{O}_3)$ —	—	8.34	8.67	—	8.51	8.51	0.0306
$(\text{La}_2\text{O}_3, \text{Di}_2\text{O}_3)$ —	—	55.30	54.87	—	55.34	55.17	0.1656
Fe_2O_3 —	—	—	—	0.24	0.26	0.25	0.0015
Combined H_2O —	5.88	—	—	—	—	5.88	0.3267
$\text{CO}_2 + \text{H}_2\text{O}$ —	—	9.36	—	—	—	—	—
H_2O lost at 100°—	—	1.50	1.49	—	—	1.49	0.0828
CO_2 —	—	—	3.59	—	—	3.59	0.0814
						99.83	

In discussing these analyses the question at once arises as to whether the carbonic acid found is an essential con-

* W. Gibbs, *American Journal of Science*, II., xxxvii., 352.

† "Fresenius's Qualitative Analysis" (Johnson's edition), p. 125.

* Rose, "Quantitative Analyse," p. 524.

† *Ber. der Deutsch. Chem. Gesellsch.*, xv., 115.

stituent of the mineral. The carbonate does not appear to bear any simple relation to the phosphate, and we have thought best to regard it as due to an admixture of lanthanite $(La, Di)_2(CO_3)_3 \cdot 9H_2O$. Regarding the water given off at $100^\circ C$. as representing only three molecules in the above formula, the remaining six going off at a higher temperature, we have the following ratio calculated with CO_2 as a basis:—

$$R_2O_3 : 3CO_2 : 9H_2O = 0.0271 : 0.0814 : 0.2456 = 1 : 3 : 9.06,$$

and there remains, after deducting the above, the ratio—

$$R_2O_3 : P_2O_5 : H_2O = 0.1756 : 0.1706 : 0.1639 = 1 : 0.97 : 0.93,$$

or the ratio of a normal phosphate, plus one molecule of water = $R_2(PO_4)_2 \cdot H_2O$.

If the water given off at 100° alone belongs to the carbonate, we have the following ratio for the carbonate:—

$$R_2O_3 : CO_2 : H_2O = 0.0271 : 0.0814 : 0.0828 = 1 : 3 : 3.06 = R_2(CO_3)_3 \cdot 3H_2O,$$

and for the phosphate—

$$R_2O_3 : P_2O_5 : H_2O = 0.1756 : 0.1706 : 0.3267 = 1 : 0.97 : 1.86 = R_2(PO_4)_2 \cdot 2H_2O \text{ nearly.}$$

The former seems the more natural supposition, and accounts for a carbonate which is known to exist. The mineral as analysed may then be considered a mixture of lanthanite with the new phosphate in the following proportion:—

Lanthanite $R_2(CO_3)_3 \cdot 9H_2O$.	Scovillite $R_2(PO_4)_2 \cdot H_2O$.
CO_2 3.59	P_2O_5 24.84
$(La, Di)_2O_3$.. 9.03	$(Y, Er)_2O_3$.. 8.51
H_2O 4.42	$(La, Di)_2O_3$.. 46.14
	Fe_2O_3 0.25
	H_2O 2.95
17.04 %	
	Scovillite .. 82.79
	Lanthanite . 17.04
	99.83 %

Below we have given the 82.79 per cent of scovillite calculated up to 100 per cent, and beside it that of a normal phosphate of the formula $R_2(PO_4)_2 \cdot H_2O$, calculated from the atomic weights obtained from the analyses and with $(Y, Er)_2O_3 : (La, Di)_2O_3 = 1 : 4$.

	Scovillite found.				Calculated.
P ₂ O ₅	30.12	29.46
(Y,Er) ₂ O ₃	10.28	11.51
(La,Di) ₂ O ₃	55.73	55.29
Fe ₂ O ₃	0.30	—
H ₂ O	3.57	3.74
				<hr/> 100.00	<hr/> 100.00

The only mineral which approaches this composition is churchite,* a phosphate of cerium, didymium, and lime, with four molecules of water. Our mineral contains less water, is free from cerium and lime, and differs also entirely from churchite in physical characters. It is therefore a new mineral species, and we propose for it the name *Scovillite*, after the locality where it was found. As to the admixture of the carbonate with the phosphate, we have been unable to decide whether this was due to a simultaneous deposit of lanthanite with scovillite, or whether the lanthanite is subsequent in formation to the scovillite and a product of its alteration. At all events the carbonate is very intimately and constantly mixed with the phosphate, as we have found no single fragment which would not give off carbonic acid when dissolved in acid. The carbonate, if resulting from the alteration of the scovillite, is not present as a superficial coating, be-

cause the fragments when dissolved in acids continue to give off carbonic acid until they are completely dissolved. We take pleasure in acknowledging our indebtedness to Mr. Adam for calling our attention to the peculiar character of this mineral, as well as for his kindness in supplying us with the material for examination.—*American Journal of Science*.

Sheffield Scientific School (U.S.), May 8, 1883.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Professor of Chemistry and Physics in the University of Cincinnati.

SILVER, POTASSIUM, SODIUM, CHLORINE, BROMINE, IODINE, AND SULPHUR.

(Continued from p. 4).

In these experiments every conceivable precaution was taken to avoid error and ensure accuracy. All weighings were reduced to a vacuum standard: from 70 to 142 grammes of chlorate were used in each experiment; and the chlorine carried away with the oxygen in the first series was absorbed by finely divided silver and estimated. It is difficult to see how any error could have crept in.

Now to combine these different series of experiments.

Berzelius, mean result	.. .. .	60.851	± 0.0006
Penny	.. .. .	60.8225	0.0014
Pelouze	.. .. .	60.843	0.0053
Marignac	.. .. .	60.8392	0.0013
Gerhardt, 1st	.. .. .	60.8757	0.0020
„ 2nd	.. .. .	60.9487	0.0011
Mauinené	.. .. .	60.791	0.0009
Stas, 1st	.. .. .	60.8428	0.0012
„ 2nd	.. .. .	60.849	0.0017

General mean, from all nine series,
representing forty experiments.. 60.846 ± 0.00038

This value is exactly that which Stas deduced from both of his own series combined, and gives great emphasis to his wonderfully accurate work. It also finely illustrates the compensation of errors which occurs in combining the figures of different experimenters.

Similar analyses of silver chlorate have been made by Marignac and by Stas. Marignac's figures I have not been able to find,† and Stas gives but two experiments. The following are his percentages of oxygen in silver chlorate:‡

25.081
25.078

Mean, 25.0795 ± 0.0010

For the direct ratio between silver and chlorine there are seven available series of experiments. Here, as in many other ratios, the first reliable work was done by Berzelius.||

* Smithsonian Miscellaneous Collections. "The Constants of Nature."

† Since all the calculations were finished I have secured a copy of Marignac's figures. They are as follows; the third column gives the percentage of O in $AgClO_3$:—

24.510 gramme $AgClO_3$ gave	18.3616 $AgCl$	25.103
25.809	19.3345	25.086
30.306	22.7072	25.074
28.358	21.2453	25.082
28.287	21.1833	25.113
57.170	42.8366	25.072

Mean ... 25.088 ± 0.0044

The introduction of these figures into the subsequent calculations could not produce any appreciable result. They would practically vanish from the general mean. However, they serve here as confirmation of Stas's work.

‡ Aronstein's Translation, p. 214.

|| Thomson's "Annals of Philosophy," 1820, v. 15, p. 89.

He made three estimations, using each time twenty grammes of pure silver. This was dissolved in nitric acid. In the first experiment the silver chloride was precipitated and collected on a filter. In the second and third experiments the solution was mixed with hydrochloric acid in a flask, evaporated to dryness, and the residue then fused and weighed without transfer. One hundred parts of silver formed of chloride :—

132'700
132'780
132'790

Mean, 132'757, $\pm 0'019$.

Turner's work* closely resembles that of Berzelius. Silver was dissolved in nitric acid and precipitated as chloride. In experiments one, two, and three the mixture was evaporated and the residue fused. In experiment four the chloride was collected on a filter. A fifth experiment was made, but has been rejected as worthless.

The results were as follows; in a third column I put the quantity of AgCl proportional to 100 parts of Ag :—

28'407 grains Ag gave	37'737 AgCl	132'844
41'917 " "	55'678 "	132'829
40'006 " "	53'143 "	132'837
30'922 " "	41'070 "	132'818

Mean, 132'832 $\pm 0'0038$

The same general method for dissolving silver in nitric acid, precipitating, evaporating, and fusing without transfer of material, was also adopted by Penny.† His results for 100 parts of silver are as follows, in parts of chloride :—

132'836
132'840
132'830
132'840
132'840
132'830
132'838

Mean, 132'8363, $\pm 0'0012$

In 1842 Marignac‡ found that 100 parts of silver formed 132'74 of chloride, but gave no available details. Later,|| in another series of determinations, he is more explicit, and gives the following data: The weighings were reduced to a vacuum standard.

79'853 grms. Ag gave	106'080 AgCl	Ratio, 132'844
69'905 " "	92'864 "	132'843
64'905 " "	86'210 "	132'825
92'362 " "	122'693 "	132'839
99'653 " "	132'383 "	132'844

Mean, 132'839 $\pm 0'0024$

The above series all represent the synthesis of silver chloride. Maumené§ made analyses of the compound, reducing it to metal in a current of hydrogen. His experiments make 100 parts of silver equivalent to chloride :—

132'734
132'754
132'724
132'729
132'741

Mean, 132'7364 $\pm 0'0077$

By Dumas* we have the following estimations :—

9'954 Ag gave	13'227 AgCl	Ratio, 132'882
19'976 " "	26'542 "	132'869

Mean, 132'8755 $\pm 0'0044$

Finally, there are seven determinations by Stas,† made with his usual accuracy and with every precaution against error. In the first, second, and third, silver was heated in chlorine gas, and the synthesis of silver chloride thus effected directly. In the fourth and fifth silver was dissolved in nitric acid, and the chloride thrown down by passing hydrochloric acid gas over the surface of the solution. The whole was then evaporated in the same vessel, and the chloride fused, first in an atmosphere of hydrochloric acid, and then in a stream of air. The sixth synthesis was similar to these, only the nitric solution was precipitated by hydrochloric acid in slight excess, and the chloride thrown down was washed by repeated decantation. All the decanted liquids were afterwards evaporated to dryness, and the trace of chloride thus recovered was estimated in addition to the main mass. The latter was fused in an atmosphere of HCl. The seventh experiment was like the sixth, only ammonium chloride was used instead of hydrochloric acid. From 98'3 to 399'7 grammes of silver were used in each experiment, the operations were performed chiefly in the dark, and all weighings were reduced to vacuum. In every case the chloride obtained was beautifully white. The following are the results in chloride for 100 of silver :—

132'841
132'843
132'843
132'849
132'846
132'848
132'8417

Mean, 132'8445, $\pm 0'0008$

We may now combine the means of these seven series, representing in all thirty-three experiments. One hundred parts of silver are equivalent to chlorine, as follows :—

Berzelius..	..	..	..	32'757	$\pm 0'0190$
Turner ..	..	..	..	32'832	0'0038
Penny ..	..	..	..	32'8363	0'0012
Marignac ..	..	..	..	32'839	0'0024
Maumené ..	..	..	..	32'7364	0'0077
Dumas ..	..	..	..	32'8755	0'0044
Stas..	..	..	..	32'8445	0'0008

General mean, 32'8418 $\pm 0'0006$

Here, again, we have a fine example of the evident compensation of errors among different series of experiments. We have also another tribute to the accuracy of Stas, since this general mean varies from the mean of his results only within the limits of his own variations.

The ratio between silver and potassium chloride, or, in other words, the weight of silver in nitric acid solution which can be precipitated by a known weight of KCl, has been fixed by Marignac and by Stas. Marignac,‡ reducing all weighings to vacuum, obtained these results. In the third column I give the weight of KCl proportional to 100 parts of Ag.

4'7238 grms. Ag =	3'2626 KCl	69'067
21'725 " "	15'001 "	69'050
21'759 " "	15'028 "	69'066
21'909 " "	15'131 "	69'063
22'032 " "	15'216 "	69'063
25'122 " "	17'350 "	69'063

Mean, 69'062 $\pm 0'0017$

* Phil. Trans., 1829, 291

† Phil. Trans., 1839, 28.

‡ Am. Chem. Pharm., 44, 21.

§ See Berzelius's Lehrbuch, 5th Ed., vol. iii., pp. 1192, 1193.

§ Ann. de Chim. et de Phys., (3), 18, 49. 1846.

* Ann. Chem. Pharm., 113, 21. 1860.

† Aronstein's Translation, p. 171.

‡ See Berzelius's Lehrbuch, 5th edition, vol. iii., pp. 1192, 1193.

Stas' experiments upon this ratio may be divided into two series.* In the first series the silver was slightly impure, but the impurity was of a known quality, and corrections could therefore be applied. In the second series pure silver was employed. The potassium chloride was from several different sources, and in every case was purified with the utmost care. From 10·8 to 32·4 grammes of silver were taken in each experiment, and the weighings were reduced to vacuum. The method of operation was, in brief, as follows:—A definite weight of potassium chloride was taken, and the exact quantity of silver necessary, according to Prout's hypothesis, to balance it was also weighed out. The metal, with suitable precautions, was dissolved in nitric acid, and the solution mixed with that of the chloride. After double decomposition the trifling excess of silver remaining in the liquid was determined by titration with a normal solution of potassium chloride. One hundred parts of silver required the following of KCl:—

First Series.

69·105
69·104
69·103
69·104
69·102

Mean, 69·1036 \pm ·0003

Second Series.

69·105
69·099
69·107
69·103
69·103
69·105
69·104
69·099
69·1034
69·104
69·103
69·102
69·104
69·104
69·105
69·103
69·101
69·105
69·103

Mean, 69·1033 \pm 0·0003

Now, combining the three series, with their thirty experiments, we get the following:—

Marignac.. .. .	69·062	\pm 0·0017
Stas, 1st series .. .	69·1036	0·0003
Stas, 2nd series .. .	69·1033	0·0003

General mean, 69·1032 \pm 0·0002

The quantity of silver chloride which can be formed from a known weight of potassium chloride has also been determined by Berzelius, Marignac, and Maumené. Berzelius† found that 100 parts of KCl were equivalent to 194·2 of AgCl; a value which, corrected for weighings in air, becomes 192·32. This experiment will not be included in our discussion.

(To be continued.)

Researches on Mesitylene.—MM. Robinet and Colson.—The authors describe a new glycol, and prove that the mesitylene dichloride and dibromide obtained by the action of chlorine and bromine upon the vapour of mesitylene are identical with the dihydrochloric and dihydrobromic ethers of this glycol.—*Comptes Rendus*.

OBITUARY.

THE LATE MR. PETER SPENCE.

WE regret to have to announce the death of Mr. Peter Spence, which took place on July 5th, at his residence, Erlington House, Seymour Grove, Old Trafford. Mr. Spence, who was in his 78th year, had been in failing health for several months. The death of Mrs. Spence, his second wife, in February, was a severe shock to him. From that time, although not suffering from any specific disease, he gradually lost strength, and ultimately passed quietly away. Mr. Spence was a man who, beginning life with few advantages, was able by sheer force of character to raise himself to a position of wealth and influence. For a long time he had held a leading place in the business in which when young he embarked, and which in some respects he revolutionised. He gave much of his time to the study of the leading social questions of his day, especially those having a sanitary or industrial bearing, and in helping on social reform he found a congenial sphere of public usefulness.

Mr. Spence was born at Brechin, in Scotland, and began his business life at Perth. His education, although good of its kind, was limited in its range and included little or no scientific teaching. He, however, early showed a liking for chemistry, and whilst at Perth he applied his spare time to the study of that branch of science. In the year 1834 he began business at Greenwich as a chemical manufacturer. Subsequently he took the control of some chemical works near Carlisle, and here in 1845, by a patient course of experimenting, he discovered a process for the manufacture of alum from the refuse shale of collieries and the waste ammoniacal liquor of gasworks. This discovery was the foundation of his success. After patenting his process, he left Carlisle and came to Manchester, choosing this city because the raw materials of his manufacture could here be readily obtained, and because the district supplied a good market for the finished article. One practical result of his invention was to lower the price of alum from 30 to 40 per cent, but it did not prove an immediate financial success. A good many difficulties had to be overcome and some heavy losses sustained before much benefit was reaped by the inventor. The Pendleton Alum Works, by successive extensions, have now become the largest in the world, being capable of turning out 200 tons of alum per week, besides other products. In addition to these works Mr. Spence also established chemical works at Goole and at Birmingham. Since he introduced his process the manufacture of alum, as of chemical substances generally, has undergone many changes. A number of these changes were the result of Mr. Spence's own researches. He took out between 50 or 60 patents, nearly all of which were for improvements in chemical processes. He was, indeed, looked upon as one of the best practical chemists of the day, and he obtained this distinction by hard work in the laboratory. In the course of his scientific experiments Mr. Spence found amongst other things that steam of 212° F. could be made to raise the temperature of saline solutions to their boiling-point, however high that might be. Thus a solution of acetate of potash might be readily raised by open steam to a temperature of 336° F. A paper on the subject was read by Mr. Spence at the Exeter meeting of the British Association. His statement was doubted by the chemists present until by actual experiment he proved the truth of what he had advanced. About ten years ago the circumstances of an accident on one of the English railways, which seemed to indicate that cold increased the liability of cast-iron to fracture, led him to undertake a series of experiments on cast-iron bars at zero (Fahr.), and he found that instead of being weakened by reduction of temperature the resistance of the iron to fracture was, in fact, increased some 3 per cent. A similar investigation

* Aronstein's Translation, pp. 250-257.

† *Pogg. Ann.*, viii., i. 1826.

made at the time by Dr. Joule gave substantially the same results. The purification of the air of towns was a subject which he had studied. He brought before the Manchester Literary and Philosophical Society, of which he was an active member, a scheme for purifying the air of a town by conducting the smoke of all house and factory chimneys along the sewers and up a column some 600 ft. in height, at which altitude he believed the law of the diffusion of gases would operate to prevent any injury to public health. The author firmly held to the theory that when smoke is completely consumed it is only the mechanical impurities which are removed, and that sulphuric acid, the element most injurious to life, remains. If his scheme did nothing else it helped to attract attention to the means of carrying away that most insidious domestic poison, sewer gas. Amongst Mr. Spence's patents is one for a furnace for calcining sulphur ores and condensing the sulphurous acid produced. This furnace has been adopted at the great copper works at Swansea, where the ores were previously burnt in the open air, to the great detriment of vegetation.

Mr. Spence was an earnest advocate of temperance. A total abstainer from his youth, there was probably no cause in which he took a keener interest. He was for a number of years a vice-president of the United Kingdom Alliance, and was largely instrumental in bringing Mr. Murphy, the founder of the Blue Ribbon Army, to Manchester. To the temperance cause, as to all public objects of which he approved, he gave most liberally. His private gifts of a charitable nature were also upon a very generous scale.

The deceased gentleman's first wife was Miss Agnes Mudie, of Dundee, and of their family of eight children seven are now living.—*Manchester Examiner*.

NOTICES OF BOOKS.

*The Coal-Tar Colour Works of the Company, formerly Meister, Lucius, and Brüning, of Höchst on the Main, in a Sanitary and Social Point of View.** By Dr. GRANDHOMME. Heidelberg: Gustav Köster.

THE effects of the coal-tar colours upon the health of those who manufacture them, who dye or print with them, or who wear goods thus dyed or printed, have been the subject of much random comment. The most exaggerated statements have been circulated concerning their dangers to public health. Dyes which do not exist at all, and others which could not by any means produce the alleged colours upon textile goods, have been charged with occasioning the most unlikely diseases. It is true that these ghastly stories bear upon the very face proof that they have been concocted by persons grossly ignorant of the subject, and invariably break down when carefully sifted. Still there is not merely scope, but need for the work before us, and for the prolonged and close investigations upon which it is founded.

These researches could scarcely have been conducted anywhere else in so satisfactory a manner. The Höchst Colour Works employ 672 men in the actual manufacture of the colours, exclusive of engineers, stokers, mechanics, packers, carters, &c., as well as of clerks and very numerous laboratory staff. There is thus a fairly broad field for observation. The products manufactured are very numerous. In addition to nitro-benzol and aniline we find mention of rosaniline (the free base), magenta, aniline blues and violets, malachite green, resorcine, eosine, erythrosine, the naphthaline yellows, oranges, browns, reds, &c., and alizarin. An important feature is that the workmen do not change about from one of these depart-

ments to another, and are expressly forbidden to enter any part of the factory save that where their regular duty lies. These regulations, whatever their primary motive, render it possible to make accurate observations on the physiological action of every kind of colour. Further, the health of the workmen is made the subject of an especial and very minute kind of book-keeping, which space does not allow us to describe, but which renders it easy to trace the health of any given workman, the cases of illness in any department, their nature, symptoms, treatment, and result.

If, after all this careful examination, it is found that the health of the workmen is fairly good, and that the majority of the cases of illness occurring are not of a specific nature connected with the physiological action of the dye-wares manufactured, we may surely conclude, *a fortiori*, that persons who come in contact with these colours in a much slighter degree are little likely to be injuriously affected. Again, any injurious properties of the raw materials, such as nitro-benzol, aniline, naphthaline, phenol, &c., though they concern the manufacturer, do not tell upon the dyer or the wearer. Magenta, *e.g.*, is made from aniline, but aniline no more exists in magenta than does farmyard manure in the grain of wheat.

The poisonous properties of nitro-benzol have been established, in addition to careful experiments upon animals, by 47 cases recorded in medical literature, fourteen of which, or nearly one-third, terminated fatally. Among the twenty-four men employed at Höchst in the nitro-benzol house there have been in the last four years 108 cases of illness; but of these forty were due to wounds, burns, &c., and only in five cases did the well-marked symptoms of "nitro-benzolismus" appear.

Aniline, again, is unquestionably poisonous. Among the twenty-nine men employed in the aniline-house there have been in the last four years 171 cases of illness: of these sixty-one were due to mechanical injuries, and eighteen arose from the specific action of aniline. None of these proved fatal, and the average duration of illness for each patient was $1\frac{1}{2}$ days. No derangement of vision has been complained of, and, contrary to the assertion of Laborve, no epileptic convulsions have been observed.

Magentas, made by the arsenic process and not duly purified, are recognised as poisons; but the symptoms recorded are those produced by arsenic, which in some inferior magentas has even exceeded 8 per cent. On the other hand, not merely observations, but direct experiments made with pure magenta—such as that made at Höchst, where Coupier's process is employed—prove its innocence. Eczema does not occur in colour works. Bergeron, Clouet, Husson, and Bertel performed experiments upon frogs, dogs, rabbits, &c., and the two first-mentioned authorities upon their own persons. In no case was diarrhoea or colic observed, and especially albuminuria was absent.

Of the fifty-two men employed in the Höchst magenta-house eleven had worked there from six to ten years, and five from eleven to eighteen years. Yet in no case was there a decrease in the weight of the body, or tendency to diarrhoea or a disturbance of the urinary secretion. The inside of the mouth was constantly reddened by the finely-divided colouring-matter inhaled, much of which would be ultimately swallowed. Yet repeated samples of their urine, as voided on Saturday evening, were found perfectly free from albumen.

The author has fed rabbits and fowls upon oats and barley dyed with magenta so as to contain 1 per cent of colour. No morbid phenomena could be traced. Even subcutaneous injection gave merely negative results.

The preparations from the residues of magenta-melt, such as maroon, phosphine, grenadine, &c., are harmless if arsenic is absent. When the arsenic process is used they contain more of the poison than does magenta, and especially grenadine may prove very dangerous. Its occasional use in the concoction of wine is therefore highly objectionable.

As regards the blue colours there has occurred in the

* Die Theerfarben-Fabriken der Aktien Gesellschaft Farbwerke, vormals Meister, Lucius, und Brüning, zu Höchst am Main, in sanitärer und sozialer Beziehung.

last four years among the thirty workmen only one case of anilism.

In the violet- and the green-houses there have occurred no cases of specific disease, though two of the workmen in the latter department have been employed there for fifteen years. Experiments with both these classes of colours upon animals gave negative results.

Resorcine is a decided, though not very powerful poison.

In the eosine department a special disease was observed—*Hyperhydrosis localis*. Nevertheless rabbits fed with barley coloured with eosine and erythrosine remained unaffected. The finished eosine does not seem to be the cause of this curious disease in the workmen, since those engaged in packing the colour are not affected, though their hands are constantly brought in contact therewith. The author suggests that washing in strong chloride of lime may be the cause; at least this affection has become both rarer and less intense since the use of strong solutions of this agent has been prohibited. In this disease the fingers become painfully sensitive, and the secretion of sweat is increased to such an extent that it falls off in drops, whilst chinks, and in some cases abscesses, appear in the palms.

In the naphthol- and orange-houses no special disease is mentioned, naphthaline being formidable only in the state of hot vapours.

No special diseases were observed in the alizarin department.

In summing up the results Dr. Grandhomme compares the mortality among the Höchst workmen with that in the army. In the latter it is 5 per 1000, in the former 4.2, which is the more favourable as 77 per cent of the workmen are over the age of 25, at which the German soldier leaves the army.

It has been found that the use of alcohol reduces the power of the constitution to bear the action of aniline. Hence applicants for work are rejected if on medical examination they are found to have the appearance of drunkards, or if evidence is obtained that they are given to intoxication. No alcoholic drinks are allowed to be brought into the establishment, and any workman arriving in a state of insobriety is dismissed.

There is appended to the book a very copious bibliography of memoirs in medical, &c., journals, and of independent works on the subject.

We must pronounce Dr. Grandhomme's treatise exceedingly valuable to aniline colour manufacturers, to sanitary officials, and to the medical profession in general. It will, we hope, frustrate the attempts made to get up a panic concerning this class of dyes.

Lectures on Practical Pharmacy. By BARNARD S. PROCTOR, formerly Lecturer on Pharmacy at the College of Medicine, Newcastle-on-Tyne. Second Edition. London: J. and A. Churchill.

In this edition the author has largely increased the Index, added certain tables, and inserted various pieces of information calculated to be useful. He has pointed out in what directions the pharmacist may most best turn his attention.

In his introductory lecture he remarks that "materia medica, therapeutics, chemistry, and botany, combined into one art formerly constituted pharmacy, but these sciences gradually becoming separate the term Pharmacy is now applied to such ill-defined and unclaimed ground as has not yet been appropriated by any of these more abstract sciences." We may here be permitted to express our regret that in England, unlike what obtains in the rest of the civilised world, the members of the pharmaceutical profession have elected to call themselves "chemists" instead of "pharmacists."

The first or "general" portion of the work deals with general subjects,—the operations of solution, crystallisation, precipitation, filtration, &c., as viewed with especial

reference to pharmaceutical requirements. The second portion treats of officinal, or, as it is now called, official pharmacy.

In the lecture on spirit of wine it appears that pharmacists still retain the somewhat clumsy habit of expressing the strength of a sample, not by its percentage of absolute alcohol, as is done by technical chemists, but by its being so-and-so many degrees above or below "proof." We venture to suggest that this system has a pre-scientific character about it, scarcely in accord with the present age.

The chapter on dispensing contains much homely but sound advice which students will do well to assimilate. The remarks on reading prescriptions, begun in this and continued in the next chapter, are gravely suggestive not only to the general public, but to chemists other than pharmaceutical. Looking over the cautions given and referring to the lithographed fac-similes of prescriptions appended we may be allowed to wonder that so few sick men are poisoned downright, and that so few dispensing chemists are accused of manslaughter. The responsibility thrown upon the latter is, indeed, unjustly heavy. We can only regard the traditional method of writing prescriptions as a survival of the unfittest, and an instance of unreasoning conservatism. The frequent abbreviations, the use of Roman numerals, and the mediæval symbols for ounces, drachms, &c., are as if intended to create mistakes. One of the most needful features in the much-talked of Medical Reform Bill would be the suppression of these follies. Haste on the part of the physician can be no excuse, since the Roman numerals take more time to write than their Arabic equivalents.

Notes on Qualitative Analysis, Concise and Explanatory
By H. J. H. FENTON, M.A., F.I.C., F.C.S., Demonstrator of Chemistry in the University of Cambridge
Cambridge: University Press. London: C. J. Clay and Son.

THE author of this manual seeks "to direct, and if possible to enforce, attention to the *rationale* of each operation performed and the nature of each reaction which takes place." He complains of a tendency existing among students to regard chemical analysis as a mere routine of mechanical operations, overlooking its scientific aspect.

The work contains, firstly, an account of the principal reactions of twenty-two of the more common metals; then of twenty-nine of the more common acid radicles. Next follow analytical tables, substantially the same as those met with in the ordinary manuals, but so arranged as to dispense with cross references. Lastly follow the reactions of some of the more common organic bodies, introduced for the convenience of medical students. The reactions of the tartrates, citrates, oxalates, and acetates have, however, been given among those of the acid radicles.

We note that, in the table of contents, the sulphocyanogen compounds are referred to as sulphocyanates; under the reactions of iron we read both of potassium sulphocyanate and potassium sulphocyanide and ferric sulphocyanide; under cobalt, also, we have mention of potassium sulphocyanide. When giving the behaviour of the acid radicles with reagents the author speaks of sulphocyanates. In the analytical tables we find the same fluctuating nomenclature. We should suspect that some students may possibly feel confused by this variation in name, and may suppose that two distinct compounds are in question. At the foot of page 9 is a note concerning the yellow ammonium sulphide commonly used in laboratories. The same note is substantially repeated at the foot of page 55.

The book is arranged and printed in such a manner that the instructions and precautions given cannot escape the eye of the student, and if there is still room for an elementary treatise of the kind it may claim a fair position.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigradé unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvi., No. 26, June 25, 1883.

Separations of Gallium.—Lecoq de Boisbaudran.—See p. 15.

Relations of Induction with Electro-dynamic Actions, and a General Law of Induction.—M. Quet.—A mathematical paper, not admitting of useful abstraction.

Maxima and Minima of the Extinction of Phosphorescence under the Influence of the Ultra-Red Radiations.—Henri Becquerel.—The author, after referring to his recent memoirs (*Comptes Rendus*, Jan. 7th and April 23rd of the present year), and to the observations of his father, E. Becquerel (*La Lumière Ses Causes et Ses Effets*, tome i.), states that the red and ultra-red rays act upon phosphorescent substances as does an elevation of temperature; when these substances are previously rendered luminous, these radiations provoke its extinction by encouraging the emission of light so that we see appear first a positive and then a negative image of the ultra-red spectrum. The phenomenon varies in different substances, and presents certain interesting phases. Beside the general phenomena of temporary excitation and extinction produced by the ultra-red radiations which present maxima and minima peculiar to each substance, we observe profound modifications in the effects obtained, depending on the physical state of the bodies, either on their state of phosphorogenic excitement, or on the nature of the incident radiations.

Automatic Impression of Telephotic Despatches.—Martin de Brettes.—The light, concentrated by means of a lens, is thrown upon a selenium element forming a portion of the circuit of the local battery which contains the coil of the electro-magnet motor of the receiver.

Thorium Sulphate.—Eug. Demarçay.—This paper will be inserted in full.

A Base derived from Crotonic Aldehyd.—Alph. Combes.—The author has obtained an oxygenated base from crotonic aldehyd by dissolving this compound in anhydrous ether, cooling to -20° , and saturating the liquid with dry ammoniacal gas. The compound obtained has a distinctly alkaline reaction, and forms a well crystallised salt with hydrochloric acid, and a double salt with platinum chloride.

Observations on Panary Fermentation.—M. Mousette.—In opposition to M. Chicandard (*Comptes Rendus*, May 28th, 1883), the author pronounces the presence of alcohol in fermented bread-paste an established fact.

Moniteur Scientifique, Quesneville.
July, 1883.

Industrial Society of Mulhouse.—Chemical Committee, Session May 9th, 1883.—This Society was engaged with the conditions of prizes offered, and with opening sealed packets of old dates, the contents of which are no longer of interest.

Session June 13, 1883.—The principal paper read was a note on the direct fixation of indigo upon cloth, which will be inserted in full.

M. H. Kœchlin exhibited specimens of woollen cloth, dyed respectively with cochineal and alizarin, and exposed to the light for three months. The cochineal was

scarcely altered, but the shades dyed with cochineal had faded perceptibly, and that the more the greater the proportion of tin present.

Industrial Society of Rouen.—A catalogue of prizes offered for researches, chiefly in connection with the tinctorial arts.

Review of Biological Chemistry.—G. de Bechi and H. Gal.—A series of extracts from German journals, relating principally to physiological and medical subjects.

The Future of the Manufacture of Chlorine.—Dr. F. Hunter.—From the *Journal of the Society of Chemical Industry*.

Industrial Review.—M. Gerber.—A list of the specifications of chemical patents, chiefly German, to which are added Dr. Armstrong's paper on the oil of turpentine and its sophistications, and Mr. L. Carpenter's memoir on the conversion of oleic acid into palmitic acid, from the same source.

Patents concerning Colouring-Matters.—An account of the specifications of German patents for the preparation of dyes.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome x., April, 1883.

The only chemical paper in this issue is a version of Mr. Walter Weldon's memoir on the present state of the alkali industry, read before the Society of Chemical Industry.

May, 1883.

Report presented by M. Bérard on behalf of the Committee of the Chemical Arts, on M. Houdart's Method for the Determination of Plaster in Wines.

—The process adopted is a modification of that of MM. Poggiale and Marty, and is carried out as follows:—Into a series of numbered test-tubes 5 c.c. of the wine are put by means of a graduated pipette, and by means of another pipette fitted with a cock there are added successively known quantities of a standard solution of barium chloride capable of precipitating respectively 1, 2, 3, 4, and 5 grms. of sulphate. Each is raised to a boil, and after having been allowed to settle a few drops of the standard barium solution is added. If, then, a fresh turbidity appears in tube 2, in which 2 grms. have been precipitated, but not in No. 3, in which 3 grms. have been precipitated, it appears that the wine contains more than 2 and less than 3 grms. of plaster per litre. We take, then, in another test-tube 10 c.c. of the wine, and add the quantity of barium solution corresponding to 5 grms. This quantity, for a double volume of wine answers to 2.5 grms. plaster per litre. By means of the verification above described it is found whether the plaster is more or less than 2.5 grms. per litre. With a little experience it is easy to appreciate a fourth of a gm. per litre—an approximation sufficient for commercial purposes.

Lecture on the Artificial Reproduction of Organic Substances.—E. Jungfleisch.—An account of the artificial production of urea, alizarin, vanillin, &c.

Determination of Phosphoric Acid in Arable Soils.—P. de Gasparin.—Taken from the *Comptes Rendus*, January 29, 1883.

Cosmos Les Mondes.
Tome v., No. 8, June 23, 1883.

Combination-heats of the Soluble Compounds of Nickel.—Dr. D. Tommasi.—The author gives the combination-heat of nickel sulphate as determined experimentally and as calculated by his law, and subjoins the calculated combination-heats of a number of nickel compounds.

Revue Universelle des Mines, de la Metallurgie, &c.,
No. 2, March and April, 1883.

Determination of Alkalies in Silicates.—W. Hempel.
—From the *Zeitschrift f. Analyt. Chemie*.

New Volumetric Method of Determining Manganese in Steel, Cast-Iron, Ferro-Manganese, &c.—E. Raymond.—The method in question is recommended as easy, expeditious, and accurate. It consists in precipitating all the manganese in the state of peroxide, dissolving it in a ferrous solution so as to bring back the manganese to the manganous state, and determining volumetrically, by means of potassium permanganate, the quantity of ferrous salt which has been converted into ferric. The method of rapidly precipitating manganese peroxide is peculiar. If we act upon cast-iron or steel with nitric acid and potassium chlorate in certain proportions, and boil the mixture, the manganese is completely precipitated in the state of peroxide insoluble in nitric acid, but retaining a small quantity of ferric oxide. Suppose that we have a sample of steel or manganiferous cast-iron containing less than 7 per cent of manganese. Three grammes are treated in a small flask with 40 c.c. of nitric acid, of sp. gr. 1.20, added little by little. The liquid is stirred, and ultimately heated to complete solution. It is withdrawn from the fire, and 15 grammes potassium chlorate are added, and then 20 c.c. of nitric acid at sp. gr. 1.40. It is boiled for about fifteen minutes, until the escape of chlorine ceases; all the manganese is found thrown down as peroxide; hot water is added, the mixture is filtered, and the precipitate washed with boiling water. To dissolve the manganese peroxide thus obtained we measure exactly 50 c.c. of an acid solution of ferrous sulphate, made up with 40 grammes ferrous sulphate to 750 c.c. water and 250 c.c. sulphuric acid (full strength). The 50 c.c. are poured into the flask in which the sample has been dissolved, and to which a little peroxide adheres, and it is then poured upon the precipitate and the filter in a Berlin-ware capsule. The manganese peroxide dissolves very readily, transforming its equivalent of ferrous sulphate into ferric sulphate. The liquid is then diluted to 100 or 150 c.c. for the next operation. We then take a solution of permanganate formed by the same proportions as are used in determining iron by the process of Margueritte (5.65 grammes of the crystalline salt per litre of water), and determine its standard exactly. By means of this liquid we determine volumetrically the quantity of ferrous sulphate remaining in the solution of manganese. We take then 50 c.c. of the original solution of ferrous sulphate diluted as above, and determine the total ferrous salt. The difference between the two determinations corresponds to the ferrous salt which has been peroxidised by the manganese peroxide. The quantity of iron thus peroxidised multiplied by 0.491 gives the quantity of manganese contained in the portion operated upon. In the case of a steel or cast-iron containing but little manganese it is convenient to dissolve the peroxide in 25 c.c. only of the ferrous solution. Small Gay-Lussac burettes may then be used in the titration of only 0.010 metre internal diameter, and graduated into $\frac{1}{10}$ c.c., which allows of great exactitude in the determination. For a spiegeleisen not more than 1 gramme of the sample should be taken, and for a ferro-manganese 0.3 gramme.

lost a man of the first distinction. While his own researches have done much to advance the progress of mathematical and physical science, his encouragement and wise counsels to other workers have also been of the utmost value. As President of the Royal Society he has fulfilled the duties of his high office with conspicuous ability and success. As one of the heads of the important public establishment, with which his family has been long connected, it is known that he afforded an admirable example of what should be the conduct of one placed in a position of so much responsibility and authority. His interest in all that tends to promote the general welfare of humanity was equally remarkable. No good work of a public nature, which came within the range of his means, was ever allowed to proceed without his aid and sympathy. His character presented a remarkable combination of intellectual strength and fine moral qualities. His judgment was unerring, and of so discreet a kind, as to ensure for it a deference which was universal. In private life his kindness, courtesy, and general culture endeared him to his friends, and engaged the regard of all who were so fortunate as to become acquainted with him. The public tribute paid to the memory of the late President of the Royal Society, by his interment in Westminster Abbey, is a striking proof of the general esteem in which he was held. It rests for the Managers to express their deep sympathy with Mrs. Spottiswoode, and the other members of Mr. Spottiswoode's family, under their heavy bereavement."

A Modification of Noack's Method for Preparing Carbonic Oxide.—Leonard P. Kinnicutt.—In the *Berlin Berichte*, vol. xvi., p. 75, E. Noack shows that carbonic oxide can be obtained by passing carbon dioxide over zinc-dust. The idea that the same gas might be more conveniently made by heating carbonates directly with zinc-dust, led me to try a series of experiments with magnesite. I found that when powdered magnesite, mixed with twice its weight of zinc-dust, is placed in a copper retort and heated so that the bottom of the retort is nearly surrounded by the flame, a gas is immediately given off, which, after the first five minutes, is nearly pure carbonic oxide. For the first five minutes the gas is a mixture of carbonic oxide, carbon dioxide, and in case the substances were not perfectly dry, a little hydrogen. In place of a retort hard combustion tubing can be used. An analysis of the gas, when given off at the rate of about four bubbles a second, collected directly from the retort and measured over mercury, gave the following result:—

Vol. of gas 152.5. $P=583.4$. $t=4^{\circ}$. Cor. $V=115.4$.

After absorption of CO_2 by KOH :—

Vol. of gas 150.0. $P=588.8$. $t=5^{\circ}$. Cor. $V=114.7$.
Per cent $\text{CO}_2=00.61$.

I have undertaken the study of the decomposition of other carbonates, but as a method for preparing carbonic oxide the above is in every way satisfactory; the manner in which the gas is given off resembling that of oxygen when made from potassium chlorate, with the advantage that the evolution is more easily controlled.—*American Chemical Journal*.

MISCELLANEOUS.

The late Mr. William Spottiswoode.—At a meeting of the Royal Institution on the 2nd inst., it was resolved: "That the Managers of the Royal Institution desire to record their profound regret for the recent death of Mr. William Spottiswoode, who for so many years, as Manager, Treasurer, or Secretary, rendered such eminent services to the Royal Institution. In him the world has

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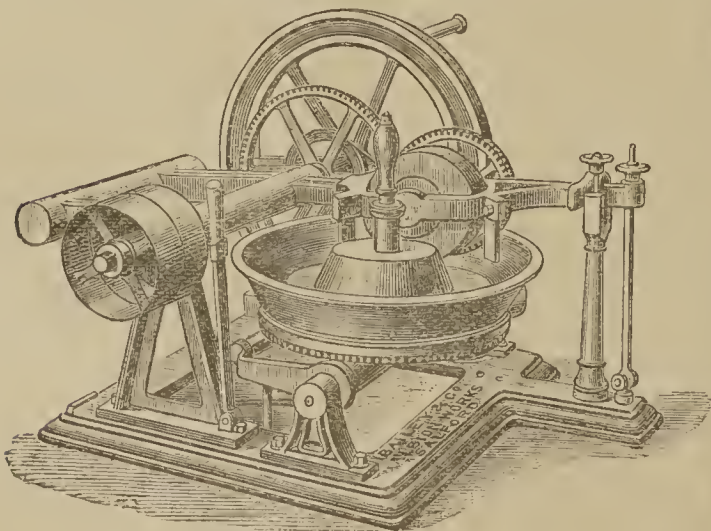
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THE CHEMICAL NEWS.

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THE CONVERSION OF CARBON MONOXIDE TO CARBON DIOXIDE BY ACTIVE (*i.e.*, NASCENT) OXYGEN.

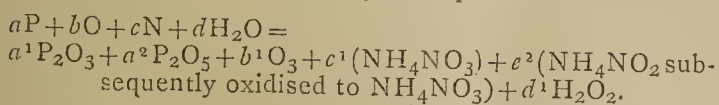
By Dr. ALBERT R. LEEDS.

IN the early part of the year 1879 I was led by certain theoretical considerations to regard it as eminently probable that carbonic oxide would be converted by nascent oxygen into the highest stage of oxidation, and that by properly devising the nature of the experiments, and adequate precautions in the execution of their details, the direct oxidation of carbon monoxide to dioxide by nascent oxygen at ordinary temperatures could be demonstrated. Repeated trials amply justified these anticipations. The final experiment, some account of which will be found in the *Journ. Amer. Chem. Soc.*, i., 232, was performed as follows:—A 5-litre jar, containing 5 sticks of phosphorus and a little water, was filled with 2500 c.c. of carbonic oxide, and the remaining space with air. The carbonic oxide was generated from potassium ferrocyanide and sulphuric acid, and washed with water, caustic potassa, and barium hydrate. On transferring it to the jar, it was again washed through a similar train of purifiers, a final U-tube filled with barium hydrate solution remaining pellucid, proving absence of any trace of carbon dioxide. The air was purified in the same manner. At the expiration of eighteen hours, the gases remaining above the moist phosphorus in the jar were drawn first through a moist cotton filter, then through a potassium iodide solution, and finally through two baryta waters. The faint rose colouration which the iodide solution struck with starch water, was found on titration to correspond to 0.04 m.grm. ozone in the total volume of gas drawn over. The last baryta water was absolutely pellucid, the first had absorbed 14 m.grms. carbonic acid. The carbonic acid estimation was made by decomposing the barium salt, and weighing the carbonic acid evolved, for fear that some traces of oxides of phosphorus might have escaped from the purifiers, and entered into combination with the baryta.

Later on, further details as to precautions employed in these experiments will be given in connection with the adverse criticisms to which they have been recently subjected.

Somewhat later in the same year a related field of experiment was entered upon. This was to determine conclusively whether or no the triatomic molecule of oxygen was capable of effecting what the individual atom of oxygen, at the moment of dissociation of the molecule of oxygen, had been demonstrated to be capable of doing.

It should be premised that the decompositions and recombinations which occur when phosphorus is oxidised at the expense of and with simultaneous reduction of the oxygen molecule, are complicated in their nature. An operose determination of the factors of this reaction (*Journ. Amer. Chem. Soc.*, vi., 146, and ii., 37) has shown that it may be represented by the equation—



The actual values of the coefficients would depend, as was shown in another place, upon the temperature at which the reduction of the oxygen molecule is effected, and the values, *a*, *b*, *c*, *d*, of the members of the equation.

But the important point established was that ozone, hydrogen peroxide, and nitro-compounds of ammonia were always formed, and their quantities always bore a certain relation to one another. Moreover, that the explanation of these facts could be found only in the supposition of the formation of active oxygen, and the subsequent generation of ozone was no more an essential feature of the reaction than the contemporaneous and invariable production of hydrogen peroxide and ammonium nitrite and nitrate.

In some earlier experiments, which had been performed with great care, by Profs. Remsen and Southwith (*Amer. Journ. Sci.*, iii., 11, 736), the conclusion had been arrived at, that carbon monoxide was not oxidised to carbonic dioxide by ozone.

As above stated, I was induced to renew the investigation (*Journ. Am. Chem. Soc.*, i., 450), inasmuch as certain preliminary experiments which I had performed had shown that carbonic oxide might undergo conversion into carbonic acid, under the same circumstances which brought about the oxidation of the oxygen molecule to the state of ozone. These were notably two:—1st. The oxidation of carbonic oxide by nascent oxygen evolved in an atmosphere of moist air over phosphorus, as detailed above. 2nd. The simultaneous formation of carbonic acid and ozone in a mixture of carbonic oxide and oxygen subjected to the influence of the silent electrical discharge. Without pausing to rehearse *in extenso* the experiments by which this latter point was established, it will suffice to state that a quantitative determination resulted in showing, that after 1½ litres of carbonic oxide had been submitted to the action of the silent discharge, in company with oxygen, 0.0271 grm. (misprinted 0.0271 m.grm., *loc. cit.*) of carbon dioxide had been formed.

Moreover, I had been enabled by the use of a modified form of Siemens ozoniser, to make use of large volumes of oxygen, raised to a higher degree of ozonation than the ozonised gas hitherto employed, and I thought that the theoretic importance of the subject warranted the institution of a fresh attempt to discover whether, with ozone of this degree of concentration, no oxidation of carbon monoxide occurred.

The actual experiment was conducted as follows:—Oxygen, previously freed from every trace of carbon dioxide, was ozonised by passage through an ozonising battery to the extent of 72 m.grms. of ozone per litre. It was then passed in excess, together with carbon monoxide likewise completely purified, through a tube 1 metre in length, which was placed *beyond* the ozoniser. But although the current of mingled ozonised oxygen and carbon monoxide was made to flow with a very slow current, and though the experiment was continued for many hours, the baryta water, through which the mixed gases finally made their escape, remained entirely pellucid. In other words, oxygen containing a very large percentage of free ozone is not capable of effecting the oxidation of carbon monoxide.

Commenting upon this result, the inference was drawn:—"In this case, the energy of combination of the two bonds, presumably free, of the carbon monoxide molecule, appears to be of less valency than the energy with which any one atom in the ozone molecule is retained by the other two. In the two former instances" (the oxidation of carbon monoxide by nascent oxygen, and the generation of carbon dioxide in a mixture of carbon monoxide and oxygen submitted to the silent discharge) "the ozone molecules are in the process of formation, and in the pre-existent stage (in which the oxygen molecule undergoes dissociation), the liberated oxygen atom is seized upon by the unsaturated carbonic oxide."

Subsequently (*Journ. Amer. Chem. Soc.*, ii., 34) these views were still further generalised in an essay which had for its object the quantitative investigation of the various factors in the complicated reactions connected with the oxidation of phosphorus in moist air. It had previously been shown (*Ibid.*, i., 8) that the amount of ozone produced by the oxidation of phosphorus under given cir-

cumstances is constant for any particular temperature, and consequently the generation of ozone may be graphically represented by a curve, the production at 6° C. being *nil*, rising to a maximum at 24° to 25° C., and then rapidly diminishing as the temperature approaches 44°, the melting-point of phosphorus.

As additional proof of the constancy of the phenomena occurring in the oxidation of phosphorus in moist air, it was established in the progress of this essay that the amounts of ozone and hydrogen peroxide bear a constant relation to one another, and to the air passed over. A similar proposition holds true of the phosphoric and phosphorous acids, and of the ammonia and nitric acid—the amounts of the latter bodies being in the ratio requisite to form ammonium nitrate. Later on it was shown that, neglecting the small amounts of hydrogen peroxide which were held back by the wash-waters through which the escaping gases pass, the ratio of the hydrogen peroxide generated was to that of the ozone as something over one to three under the conditions of that particular experiment.

These various results caused me again to reiterate the wide generalisation which had been brought forward in the earlier articles concerning the production of ozone under the conditions studied—that it was connected with the uneven quantivalences of the elements taking part in the reaction. “If this hypothesis be true, then we should anticipate the development of ozone whenever oxidation of a perissad occurred at temperatures compatible with the stability of the ozone molecule, even at the temperature of combustion of hydrogen; this is supposed by C. Than to be the case. He explains in this manner the presence of the ozone, which he states he has detected in the combustion of hydrogenous substances generally, and its absence in the combustion of carbon.”

“In entering into new combinations, the oxygen molecules must undergo temporary resolution into their constituent atoms. These, while *en route* to take up new positions in other combinations, and animated by their atomic energy, or energy of the nascent state, may either oxidise the oxygen molecule, or the nitrogen molecule, or the molecule of water. In the first place, ozone would be produced; in the second, regarding water as the basic body and NNO as the nitrile, there might be formed, as Hunt has indicated, ammonium nitrate; in the third, hydrogen peroxide.”

This recapitulation is here given in order to recal the gradual evolution of the hypothesis of the necessary existence of active or nascent oxygen, as a body distinct from ozone, in order to explain observed phenomena. According to these views the oxidising effect of palladium-hydrogen, as noted by Hoppe-Seyler, at a later period in the history of these researches,* was a particular case of the oxidation of a perissad (in this case, hydrogen) at a temperature especially compatible with the stability of the ozone molecule. The intervention of nascent hydrogen, or active hydrogen, is not needed to explain the production of hydrogen peroxide when hydrogenium or palladium-hydrogen comes in contact with water. Hydrogenium is a perissad metal endowed with the most eminent de-oxidating or reducing powers. When it reduces the molecule of oxygen, a temporary resolution of the molecule into its constituent atoms must necessarily take place. In other words, hydrogenium stands in the same relation to the production of hydrogen peroxide as phosphorus does when oxidised in presence of moist air. Like the phosphorus it directly reduces the oxygen molecule, and sets free the oxygen atom. This active oxygen so formed is the efficient cause of all the subsequent phenomena. It starts the series of chemical changes, and is the principal and all-important factor, as related to which and resulting from which the generation of the ozone, hydrogen peroxide, and ammonium nitrate and nitrite, are three correlative

and necessarily dependent, but inevitably and indissoluble connected, consequences. According to this hypothesis, the generation of ozone is not the central fact around which the possible formation of active oxygen and the other phenomena are grouped, but it is a secondary phenomenon, and is of no more importance, so far as the theory of the reaction is concerned, than the simultaneous development of hydrogen peroxide, and, in presence of nitrogen, of nitrogen compounds.

The foregoing history of previous investigations is given in order to render intelligible the attitude in which I stood with regard to the statements recently made by I. Remsen and E. H. Keiser in a paper “On the Conduct of Moist Phosphorus and Air towards Carbon Monoxide” (*Amer. Chem. Journ.*, iv., 454). It will be further necessary only to state that these views are not the same as those advanced by Hoppe-Seyler, as may be seen from different induction which I drew from Hoppe-Seyler's own experiments. For in his original experiments this investigator did not suspect the necessary presence of peroxide of hydrogen, as an indispensable factor in the reactions observed. Subsequently (*Ber. der Deutsch. Chem. Gesell.*, xiv., 976) I pointed out that this must be the case, and on performing the experiment quantitatively determined the amount of peroxide formed. The only reasons for previously anticipating, and actually performing the experiments confirmatory of, the presence of hydrogen peroxide, were the theoretical considerations connected with the development of active oxygen above enunciated. Ignoring these results, M. Traube in a later issue of the *Berichte* (xv., p. 659) brought forward the formation of hydrogen peroxide under these circumstances, as his own observation, and has founded upon this production of hydrogen peroxide a hypothesis, concerning the validity of which, and concerning the experimental verification of the experiments upon which it is based, I shall defer writing until the publication of a subsequent article.

After recounting certain preliminary experiments, the crucial one, by which Remsen and Keiser hold that they conclusively established the non-conversion of carbon monoxide to dioxide in the presence of moist air and phosphorus, and so far as the evidence afforded by this experiment is concerned, the non-existence of active oxygen, is stated as follows:—

“An apparatus was finally constructed in which these were entirely excluded, or, at least, so protected that the ozone could not possibly reach them. Although a number of different forms of apparatus were tried, we need only describe that which we finally decided upon as the best. This consisted of a flask of from 3 to 4 litres capacity, provided with a doubly perforated cork stopper. Through this there passed one glass tube reaching to the bottom of the flask, and another reaching only half way. Outside the flask the shorter tube was connected with the apparatus intended to remove the carbon dioxide from the air, and the longer tube was bent twice at right angles, and then passed through the stopper of a U-tube about 8 inches high. Between this U-tube and a second like it, connection was made by means of a doubly-bent glass tube. In the flask there were placed usually two or three sticks of phosphorus each 3 or 4 inches long, and enough pure water to somewhat more than fill the neck when the flask was inverted. The U-tubes were filled with ignited asbestos, and there was then added some mercury so that when the tubes were inverted, in which position the entire apparatus was placed when in use, the metal covered the corks with a layer from three-quarters of an inch to an inch in thickness. The connecting tubes passed, of course, in each case through the layer of mercury. The vessel containing the clear baryta water was also connected with the last U-tube by means of a mercury joint similar to those above described. The baryta water was protected from the action of the air by placing before it a small U-tube containing potassium hydroxide, and this last tube was connected with an aspirator. Before connecting the bulbs containing the baryta water, air freed from carbon

* “Activation of Oxygen by Nascent Hydrogen,” *Ber. der Deutsch. Chem. Gesell.*, xii., 1551.

dioxide was drawn slowly* through the apparatus. On now connecting with the baryta water bulbs no precipitate was formed. Even on allowing the air to remain in contact with the moist phosphorus for periods varying from one to twelve hours, no carbon dioxide could be detected. This experiment was tried over and over again at different temperatures, but always with the same result.

"About one-third of the air in the ozone flask was now replaced by carbon monoxide from which all dioxide had been scrupulously removed. The mixture was allowed to stand for some hours, and then drawn through the baryta-water bulbs, when no precipitate was formed. This experiment was repeated a number of times with the same result. In some cases the air and carbon monoxide were drawn together slowly for a long time over the moist phosphorus, but this made no difference in the result. So frequently was the experiment performed, so great were the precautions against error, and so undeniably negative were the results, that, in spite of the explicit statements of Leeds and of Baumann, we do not hesitate to say that carbon monoxide is not oxidised when exposed to the action of air and moist phosphorus. It follows, of course, from this that the action of air and moist phosphorus on carbon monoxide furnishes no evidence in favour of the view that there is an active condition of oxygen distinct from ozone."

The authors further say:—"Leeds's error is easily explained. In the first place he took no special precautions to protect the corks from the action of the ozone, and in the second place he passed the gases through a filter of moist cotton for the purpose of removing 'oxides of phosphorus.' Now cotton, as it is usually met with, yields carbon dioxide when subjected to the influence of ozone, so that the carbon dioxide noticed by Leeds was probably the result of the action of ozone on the cotton or the oily substances which always adhere to it."

With regard to this explanation it may be said that at a very early stage in experimenting with ozone, the observer is compelled to note the destructive action of ozone on corks and rubber connections, and either to eliminate them altogether or to boil the corks in paraffin and cover them with the same, both of which last precautions were taken in the present instance. The action of the very attenuated form of ozone obtained from phosphorus is excessively slight, as I knew when speaking of its employment in connecting ozone apparatus at a later date (*Journ. Amer. Chem. Soc.*, ii., 150):—"Paraffin does not perfectly withstand the action of ozone, being slowly decomposed with the formation of carbonic acid. In the course of long-continued use, the paraffin joints employed by the author in connecting the ozonising elements of his large electrical ozoniser (*Ibid.*, i., 440) were destroyed, and had to be renewed from time to time. The amount of action on the joints was progressive, the paraffin connection between the first and second ozonising element requiring to be changed very seldom, while that between the eleventh and twelfth elements needed frequent renewal."

"In experimenting with ozonised air, containing so small an amount of ozone as that employed in the investigation described in the present article" (ozonation by phosphorus), "the connections may be made of paraffin without entailing serious error, but in researches of greater nicety, where not merely the relative but the absolute amounts of ozone have to be determined, paraffin connections cannot be employed."

The cotton employed to remove the oxides of phosphorus—and I should have added in this as I have in other places, that cloud of vesiculated peroxide of hydrogen (the antozone of Schönbein and other authors), which by its passage through water, &c., without absorption so puzzled the earlier experimenters,—this cotton, I repeat, was not the common cotton wool of commerce. It had been previously treated with alkali so as to remove all

fatty matters, and then repeatedly exhausted with water and dilute acid, until its reaction was neutral, all soluble matters removed, and a white fibrous material as near pure cotton fibre as possible had been obtained.

Still, in performing a crucial experiment, it was certainly important to eliminate every surface of contact except those of glass and water. Even mercury, or any other possibly oxidisable metallic surface, is objectionable, on account of a possible deozonation of the very minute amounts of ozonised air, which are formed by ozonation with phosphorus.

But before stating the details of this experiment, it will be well to narrate that performed by Baumann (*Zeit. f. Physiol. Chem.*, v., 250), who subsequently to my own labours effected the conversion of carbon monoxide to dioxide at ordinary temperatures by means of active oxygen. He writes—"A slow stream of air free from carbonic acid was conducted through a flask containing moist phosphorus; thence into a second flask containing a mixture of 3 vols. oxygen and 1 vol. carbonic oxide, and finally through baryta water. The last remained perfectly clear after the gas had been passed through it for six hours, and after every trace of carbonic acid had been previously removed from the apparatus. On the other hand, when the mixture of carbonic oxide and oxygen was conducted into the flask containing phosphorus, and in which there must have been, according to our proposition, active oxygen, an altogether different result followed: the baryta water presently became turbid, and in an hour threw down an abundant precipitate of barium carbonate."

Commenting upon the above, our critics say:—"Nothing is said about stoppers or rubber connections, and it is safe to assume that, in the apparatus used by Baumann, ozone came in contact at some points with organic matter. Hence the formation of carbon dioxide is easily accounted for." . . . Whatever the sources of error in Baumann's experiment may have been, we are confident that a repetition with the precautions taken by us will show him this—his conclusion is wrong."

It is not our duty, but that of the writer impugned, to inform us whether this confidence in his having neglected to take the most obvious and indispensable precautions in the conduct of his experiments is well founded.

My own repetition of the original investigation was performed as follows:—

Seven 6-inch sticks of clean phosphorus were placed in a 10-litre flat-bottomed bottle, with an accurately fitting glass stopper, the bottle filled with air- and carbonic acid-free distilled water, and inverted in a small pneumatic trough, likewise filled with distilled water. Carbon monoxide, which had been made several days previously, and allowed to stand over distilled water in a glass gas-holder, was purified by passing through a long train of purifiers similar to those employed in connection with carbon determinations in steel, and to which additional wash-bottles containing caustic potash and baryta water had been added. Whatsoever carbon dioxide was present originally was so thoroughly removed that the baryta water in the last wash-bottle remained absolutely limpid, on passing sufficient carbonic oxide into the ozonator bottle to fill it nearly one-half. An equal quantity of air, after passage through the same train of purifiers, and equally well freed from the dioxide, was then introduced into the ozonator. While the bottle was still inverted in the trough the tight-fitting stopper was introduced, and it was then reverted, sufficient water being allowed to remain in the jar half to cover the phosphorus. The bottom of the bottle being flat, on distributing the sticks by gentle shaking they were partly and uniformly submerged, and exposed to the largest possible amount of deoxidising surface.

The ozonator still standing in the water of the trough was then brought to a temperature of 24° C. by heating the trough, and kept at this temperature for six days. The antozone cloud (*i.e.*, suspended hydrogen peroxide) produced the first day gradually subsided, and the atmosphere

* This operation requires care and constant attention. The phosphorus not unfrequently takes fire. In one case in our experience it took fire after having stood quietly and unmolested for several hours.

became perfectly clear. The very gradual disappearance of these clouds—in part due to the gradual interaction of ozone and hydrogen peroxide with the formation of water and ordinary oxygen, and in part due to the mechanical difficulty with which the peroxide when once brought into a condition of aëriiform, and probably vesicular, suspension goes into solution in water—strongly countenances the supposition that they are mainly, and probably entirely, suspended hydrogen peroxide. The energy with which the oxides of phosphorus unite with, and are absorbed by, water, makes it an untenable supposition that they could, even if formed, remain for any length of time suspended in the atmosphere, so that whilst in my earlier experiments it seemed easier to suppose the clouds to be oxides of phosphorus than a non-volatile body like hydrogen peroxide in a state of aëriiform suspension, yet later on the latter explanation was proved experimentally to be the correct one.

At the expiration of six days the atmosphere contained in the bottle was withdrawn by the following manipulation, all contact with organic surfaces, except for a few seconds when the atmosphere remaining in the bottle came in contact with paraffin, being impossible:—

The glass stopper was removed, a cork saturated with paraffin, through which the necessary connecting tubes passed, inserted, and instantly the mouth of the bottle plunged beneath the surface of a mercury trough. This inversion carried the phosphorus and water down, so that the water covered the paraffined cork. Then the cork was quickly loosened, and the aspiration, being connected with the series of connecting tubes, but no air being allowed to enter, mercury was drawn up into the flask sufficient to cover the paraffined surface. The cork being forced back again, remained covered with mercury during the remainder of the experiment.

The glass tubes were so bent that no breaks or connections in them occurred between the atmosphere contained in the baryta water of the last wash-bottle, through which the air was aspirated to take the place of the atmosphere contained in the ozonator, and the baryta water contained in the wash-bottle, through which the mixture of carbon oxides and air remaining at the close of the experiment was finally passed. No break, except in the ozonator itself; and here it occurred above the surface of the water, the displacing air entering near the bottom, the gaseous products passing out from the upper portion of the jar. To prevent the diffusion backwards into the last wash-bottle of the entering current of any of the atmosphere in the ozonator, a bulb was blown on one of the lower curves of the entrance tube so as to form a mercury valve. Such a precaution was not necessary on the escaping tube, its end dipping directly beneath the surface of baryta water. This baryta water was again protected from the action of the atmosphere by being connected with another wash-bottle containing neutral solution of potassium iodide. On now aspirating a current of air freed from carbonic acid through the apparatus, an abundant white precipitate formed in the collecting flask, and eventually a white crust formed on the sides of the entering tube beneath the surface of baryta water. When the atmosphere of the ozonator had been completely changed and no further precipitation occurred, the contents of the wash-bottle were transferred to a carbonic acid apparatus, and the percentage estimated in the ordinary manner. The air used in aspirating was freed from carbonic acid likewise. The weighings were as follows:—

Potash bulbs after decomposition and aspirating	43·8295 grms.
Potash bulbs before do. do. ..	43·8140 "
Increase in weight (carbon dioxide) ..	0·0155 grm.

There was no difficulty in obtaining a qualitative test for carbon dioxide from the white crust adherent to the entrance tube, and the amount of which should properly

form a part of the 15·5 m.grms. actually weighed. On cutting off this tube with its white crust, dropping it into a test-tube, and allowing a drop of acid to run down the crust, it was energetically decomposed with the formation of bubbles of gas, and a drop of lime water properly supported on the under side of a glass cover stopping the exit of the test-tube, became turbid.

Objections to the fact of the above experiment, being conclusive as to the production of 15·5 m.grms. and upwards of carbon dioxide:—

1st. That there was an interval during which at the close of the experiment the atmosphere of the ozonator was in contact with the paraffined cork. Admitting that the air in this experiment was sufficiently charged with ozone to decompose paraffin, yet, as a matter of fact at the close of the experiment, no ozone was present. The potassium iodide in the final wash-bottle, after acidulation, contained no free iodine. And, as it should properly be objected that this negative result is inconclusive, on account of the combination of nitrogen and ozone in presence of alkaline liquid to a nitrate, it should also be remembered that this reaction would not have been sufficiently energetic to detain every trace of residual ozone. In my earlier experiment, in which 5 litres of air had been used, and the amount of carbon dioxide formed was 14 m.grms., the amount of residual ozone was only 0·04 m.grm.

2nd. The water contained sufficient ozone in solution to decompose the paraffin submerged beneath in the instant of time before being covered with mercury. This is eminently improbable, since the establishment of the fact that ozone is soluble at all was a very laborious matter, and was only successful after many long-continued qualitative tests made with very highly ozonised oxygen (*Journ. Amer. Chem. Soc.*, 1, 220).

The same remark applies to the possibility of the dissolved ozone being converted into ordinary oxygen in contact with the mercury covering the paraffined cork.

3rd. It may be said that even if we grant that carbon dioxide was formed, it might have resulted from the combined action of ozone and hydrogen peroxide, both of which oxidants were certainly present. But inasmuch as neither of these bodies alone effects the oxidation of carbon monoxide (and Prof. Remsen's own experiments are conclusive as to this point), and inasmuch as their mutual action is not of an oxidising but of a reducing character, both bodies being reduced, the one to oxygen, the other to water, the above supposition is untenable.

I hold, therefore, that the fact of the oxidation of carbon monoxide to dioxide by air over moist phosphorus, has been established by a rigid quantitative and qualitative analysis. Moreover, that this oxidation is, as I have always held it to be, the proof of the existence of active oxygen, as a body antecedent to the formation of ozone.

The essential feature in my own interpretation of the phenomena studied is that active oxygen is always formed when reduction of the oxygen molecule occurs at temperature compatible with the stability of the ozone molecule. That nascent hydrogen is not essential to this reduction is shown by the reduction being effected by phosphorus, in which case the intervention of nascent hydrogen does not occur. Hydrogen and phosphorus are probably only the two most conspicuous of the bodies capable of reducing the oxygen molecule at ordinary temperatures, and whilst both these are perissads and this fact appears to be connected with the production of active oxygen, I am not able in the present state of experimental knowledge to say that the perissad nature of the reducing element is an essential feature of the formation of active oxygen. As I have repeatedly stated, the essential part of my hypothesis is the reduction of the oxygen molecule at a temperature compatible with the stability of the ozone molecule. Even without chemical intervention, the silent electrical discharge will do this, and form primarily active oxygen and secondarily ozone. That such is the case is

shown by the formation of carbonic dioxide when a mixture of carbon monoxide and oxygen are submitted to the silent discharge.

Stevens Institute of Technology,
April 15th, 1883.

METHODS OF ANALYSING SAMARSKITE

AND THE OTHER COLUMBATES CONTAINING EARTHY OXIDES, BY THE AGENCY OF FLUORHYDRIC ACID; AND OF DISSOLVING COLUMBITE AND TANTALITE BY THE SAME ACID.—ON THE SEPARATION OF THORIA FROM THE OTHER OXIDES.—QUANTITATIVE ESTIMATION OF DIDYMIUM OXIDE IN ITS MIXTURES WITH OTHER EARTHY OXIDES.

By J. LAWRENCE SMITH, Louisville, Ky.

(Concluded from p. 15).

As it has been necessary to use letters to indicate the various groups of constituents of this mineral, they will be stated in a list, for easy reference.

A—The portion of samarskite soluble in fluorhydric acid.

B—The portion of samarskite insoluble in fluorhydric acid.

C—The mixed oxalates of the earths from samarskite.

D—The earthy oxides insoluble or dissolved with difficulty by the sulphate of potassium or sodium.

From the time that samarskite was discovered until I undertook the examination of the mineral as it was found in Mitchel county, N.C., the earths from the ignited oxalates were considered to be the oxides of the cerium group and yttria group, and in my researches made in 1876 and 1877, while I referred to one of these oxides as cerium oxide, in a footnote* I stated that there were grounds for belief that the oxide so called was not cerium oxide, as it was completely soluble in a very dilute solution of nitric acid.

A little later, by repeated precipitation of this oxide (as prepared from samarskite) with sodium sulphate I obtained an oxide, the sulphate of which is absolutely insoluble in a concentrated solution of the sulphate. The oxide of this was completely soluble in very dilute nitric acid. In many respects it resembled cerium oxide. Among them it did not furnish any absorption ray in the spectrum, but its complete solubility in very dilute nitric acid was a marked distinction between it and cerium oxide. For this reason I considered it a new oxide and called it mosandrum. The atomic weight of the oxide was made out to be 109 (O=16).

M. Marignac, however, as well as Prof. Delafontaine, was inclined to regard the oxide as terbia. The properties of this latter earth were never clearly understood, yet as far as I have been able to make them out I considered it to differ from what I had called mosandrum. Not having any absorption ray, it is not so easy to decide upon as upon most of the earthy oxides.

The study instituted upon the earths coming from samarskite opened a new field of investigation upon the earths of the cerium and yttrium groups, especially among those which give marked and decided absorption rays. As yet they cannot be separated in a pure state in sufficient quantity for a complete chemical study, at least so far as my information at the present time goes.

Prof. Delafontaine, of Chicago, has done some excellent work on these earths, among which he considers that he has discovered two vessels that are new, philippium† and decipium. In regard to the first, the spectroscopic and other characteristics are well defined, so much so that those chemists and physicists who have examined it, as MM. Marignac, Soret, and Lecoq de Boisbaudran, have

no doubt upon the subject. As regards decipium* the spectroscopic examination of Soret and Lecoq de Boisbaudran has not as yet furnished us with any positive decision, as far as my information extends at the present time. M. Delafontaine, however, feels satisfied about it.

In addition to the above, M. Marignac has separated another, working, however, on gadolinite and euxinite, which he calls ytterbium,‡ and L. F. Nilson another, which he calls scandium,§ and believes to be associated with the ytterbium of Marignac. It is determined by spectroscopic examination of a somewhat complicated nature. I would here state that most of these new earths have only been made out by a very small quantity, sometimes less than a gramme, the spectroscopic work being done by the most skilful observers.

The use of the spectroscope in studying the earths requires great care, and sometimes the presence of a very minute quantity of some foreign substance may lead to wrong conclusions. Thus the presence of traces of uranium caused Soret to mistake zirconia for a new oxide that he called jargonite, and some similar cause induced Delafontaine|| to consider that there was a marked difference between the didymium oxides of cerite and samarskite, didymium oxide of cerite being a mixture of different earths. Soret,§ however, showed that the didymium oxide from samarskite, as furnished him by Marignac, was the same as that from the oxide from cerite. Lecoq de Boisbaudran came to the same conclusion from the oxide I had furnished him as coming from samarskite. A still more curious fact is that, in some experiments I had made in connection with Lecoq de Boisbaudran, a peculiar treatment of pure didymium oxide by acids so altered the most important absorption ray furnished in the spectrum of that earth as to destroy its characteristics.¶

Up to the present time the following earths have been found in samarskite. I give the list as made out by Delafontaine, with the exception of mosandrum, which he does not recognise:—

Yttria,	Thoria,
Erbia,	Oxide didymium,
Terbia,	Oxide cerium,
Philippia,	Mosandria,
Decipia,	

The proportion of each of these earths in the 14 per cent of earths it is impossible to state. As regards the thoria it is about 0.50 of the mineral. The oxides of cerium and didymium exist only in traces.

The method of separating most of these earths is by fractional precipitation with oxalic acid, or by some alkali as employed by myself. Operating with the ignited nitrate is used in other instances, but in whatever manner the separation is attempted it is attended with difficulty and greatly reduces the quantity of the residuary oxide which is sought for.

It is the insoluble precipitate D that furnishes the difficult problem of quantitative analytical chemistry, and several earths of yet undefined character have been more or less perfectly separated. I will give some of my own labours in that direction.

Many interesting results have been worked out by Marignac, of Geneva, and Delafontaine, of Chicago; but the slow, tedious processes that have to be employed will delay those labours very much.

The method by which I made some imperfect operations on the oxalate C is as follows:—The powder is dried, ignited, and weighed. It has a pale yellow colour, and consists of several earthy oxides. It is completely soluble in dilute or strong nitric acid. The solution of it in the acid is evaporated to the consistency of thick syrup, thus driving off nearly all the free acid. To this syrupy mass, before

* *Comptes Rendus* 1878, 86, 632.

† *Ibid.*, 1879, 87, 578.

‡ *Ibid.*, 645.

§ *Ibid.*, 1877, 85, 634.

§ *Ibid.*, 1878, 86, 422.

¶ *Ibid.*, 1878, 86.

* *Amer. Journ. Science*, May, 1877.

† *Comptes Rendus*, 1878, 86, 559.

it solidifies,* about 50 c.c. of a concentrated solution of sulphate of potassium or sodium (lately I have used the sodium salt altogether), and mixed into the mass. It gives at first a clear solution. To this is added three or four grms. of small crystals of the sulphates, the whole stirred frequently and allowed to stand for 24 hours. A precipitate soon begins to form, and at the end of the time is quite abundant. It is now thrown into a filter and thoroughly washed with a concentrated solution of potassium or sodium sulphate, but at no time will the filtrates be entirely free from a trace of the insoluble double sulphate. This precipitate is called D. The filtrate is supposed to contain yttria and erbia. To it is added oxalic acid or ammonium oxalate, the precipitated oxalate burnt, re-dissolved and re-precipitated† by the oxalate, then burnt, and after very thorough ignition, weighed. This oxide is then dissolved in dilute sulphuric acid, evaporated carefully to dryness, and heated nearly to red heat, until its weight is constant. This is noted, and from the weight of the oxide and that of its sulphate, the relative proportion of yttria and erbia is estimated by the formula of Bahn and Bunsen:—

$$x = 4.906A - 2.4540 B.$$

x = the erbia contained in A; the oxides, which give B, the sulphates.‡ The first precipitate by the sodium sulphate, washed with a solution of the same, is dissolved in hydrochloric acid, and first precipitated as oxalates, then changed into oxides by ignition. It is in this oxide that I searched for mosandrum by repeated precipitation with sodium sulphate and re-conversion into oxides, when I obtained an oxide as dark as cerium oxide, dissolved in minute quantity in sodium sulphate and perfectly soluble in very dilute nitric acid, after 30 minutes' contact.

The insoluble double sulphates D precipitated from the solution of the earths may contain any or all of the other cerium oxides and thoria. This is dissolved in water containing a little chlorhydric acid, by the application of heat; the solution is then nearly neutralised by ammonia and precipitated by oxalic acid or oxalate of ammonia, the precipitate is burnt, re-dissolved in nitric acid and re-precipitated by the oxalate, which is well burnt and weighed.

This was originally supposed to be the cerium group of earths, but when rubbed up with a little water it is completely dissolved§ in dilute nitric acid (1 acid to 100 water), in from 15 to 30 minutes, showing the absence of cerium oxide, or if present only to the extent of a mere trace.

To test this fact still farther, I precipitated the earth from its nitric acid solution by caustic soda, adding just enough to make the solution alkaline, then added 3 to 4 grms. of caustic soda, and adding water enough to make the mixture 50 c.c.; it is quite thick from the gelatinous precipitate. A stream of chlorine gas is now passed slowly through the mixture for 2 or 3 hours, in the manner recommended by M. Mosander for separating cerium oxide from its associated earths. But none of the indications of colour peculiar to cerium oxide are manifested, but all the oxides are taken into solution except a small quantity of a white gelatinous precipitate. This precipitate was collected on a filter and washed, detached from the filter and dissolved by means of a few drops of sulphuric acid, evaporated to dryness, heated to drive off the excess of acid, and when dissolved in a little cold water and examined, was found to be thoria.|| It was afterwards precipitated by ammonium oxalate, burnt, and weighed, and represented

* We are supposed to be operating with one or two grms. of the mineral.

† This second precipitation is always necessary when we are analysing these earths, and the first solution contains potash and soda.

‡ In the use of this method of operation it was supposed that cerium oxide and yttria could be easily separated from each other by the bisulphate of potassium and sodium, and the oxides remaining in solution were yttria and erbia, but more recent research has shown its defective character, and it is no longer adapted to furnish any good method.

§ This is based on the supposition that there is no other oxide present.

|| The cold solution when heated was changed into a mass of delicate silky crystals so remarkably characteristic of thoria.

0.80 per cent. This is a new and valuable method of separating thoria, which will be treated of in another part of this paper.

The fact of the absence of cerium oxide led to a thorough examination of the D precipitate; for the Russian variety of samarskite contains cerium. But to do this I had to make the study upon a much larger quantity of the earths than that obtained from 5 grms. of the mineral, which contain only about 4 per cent. of the D oxides, so that what follows is based on the use of ample material obtained from several kilograms. of the mineral.

In this large operation I did not use platinum vessels for the first treatment, but lead vessels, the decomposing vessels being of the capacity of four litres, and capable of working more than one kilogram. at a time, and the mineral was sufficiently divided by passing it through a wire sieve with $\frac{1}{2}$ m.m. meshes (less than 30 minutes being required to prepare a kilogram. for the action of the fluorhydric acid). The mineral is placed in the lead capsule and 750 c.c. of water poured upon it, then one kilogram. of fuming fluorhydric acid is added by degrees, and the mixture stirred with a lead rod until the violence of the action ceases. Then a second kilogram. of acid is added and stirred in. The capsule is now placed on a water-bath and heated, with occasional stirring, for two or three hours, when the action is complete, and we proceed as already described with the 5 grms.

When the insoluble fluoride of the earths are obtained I find the following the best way of changing them to oxalates. 250 grms. of the dry fluorides rubbed up in a mortar and placed in a platinum capsule, and then 250 c.c. of concentrated sulphuric acid are added without water; the mixture stirred and heated over the flame until nearly dry, and after cooling, dissolving in water and uranium oxide farther oxidised by nitric acid. After filtration the whole is diluted to about 5 litres, boiled by a current of steam, nearly neutralised and then precipitated by 225 grms. oxalic acid dissolved in one litre of water. The oxalates thus obtained are operated with as already described for the separation of yttria, using either potassium sulphate or sodium sulphate. The latter has certain advantages in large operations. The thoria of the earth is with that part which is difficultly soluble in sodium sulphate.

Separation of Thoria.

The separation of this earth from the others with which it is usually associated is attended with more or less difficulty and uncertainty. These earths are of the cerium group, for the concentrated solution of potassium sulphate precipitates the thoria along with these earths. One of the best methods is considered to be that by sodium hyposulphate, but the use of it did not enable me to decide upon the presence of thoria when I made the examination for my mineralogical paper on the "Columbic Acid Minerals of the United States,"* while the method about to be described makes it easy of detection and quantitative separation; so much so that I am satisfied that by means of it the metal thorium will be found to be more generally diffused than it has been supposed to be.

If thoria be precipitated from a solution of any of its salts by the fixed alkalies, and the gelatinous precipitate added to a little water containing four or five times its weight of caustic potash or soda, and a current of chlorine has passed through it for any length of time, none of the thoria will be taken into solution; and if the other earths usually associated with thoria be present, the same result will take place as regards the thoria, but all the other earths will be dissolved with the exception of the cerium oxide. These facts have been fully verified by a special set of experiments. The thoria in the samarskite was estimated in this way,† and no analytical result could be more satisfactory, sufficient care being taken to pass chlorine

* *Am. Journ. of Science*, 13, May, 1877.

† As already described where treating of the absence of cerium oxide in the samarskite.

gas through the solution long after it is supposed to be saturated. Two or three hours is not too long where $\frac{1}{2}$ to 1 grm. of the mixed oxides is operated with.

Separation of the thoria from the mixed earths by ammonia.—When thoria has to be separated from a large quantity of its associate earths, the chlorine method is long, and the insoluble part has to be separated and treated two or three times before complete separation is accomplished. I accomplished this by an excellent method, but one not intended to furnish quantitative results like the chlorine method.

Using, say, 50 grms. of the earths separated by the potassium or sodium sulphate, dissolve it in nitric acid somewhat diluted, and concentrate over a water-bath, add the contents of the capsule to about three litres of water, boil by current of steam or otherwise, and, when in a state of ebullition, neutralise by ammonia until only a few flakes remain undissolved; then add by degrees an ammonia solution of known strength and just sufficient to precipitate 6 or 8 grms. of the oxides,* the solution being made to boil violently during the operation. This ebullition is continued for about five minutes. A bulky gelatinous precipitate will be formed which contains all the thoria and a little of the other oxides. This is thrown on a filter and washed. This takes place very slowly. The gelatinous precipitate is dissolved in a dilute solution of sulphuric acid, evaporated to dryness, excess of acid driven off, re-dissolved in cold water. By boiling and evaporation it separates in its well-known form, which, when hot, is separated from the mother-liquor. The sulphate of thorium thus obtained is not perfectly pure, but if wanted for chemical investigations it can be purified by the usual method. This separation clearly arises from the fact that the thoria is less basic than the other earths.

The filtrate from the gelatinous precipitate is treated with oxalic acid, and the precipitated oxalate dried and ignited, giving a salmon-yellow oxide that is further examined by processes to be described. The fact that these earths have only a mere trace of thoria remaining in them is established by the fact that, when 1 grm. of them is treated by the chlorine test for thoria already described, all the oxides are completely dissolved except 4 milligrams. I then recommend this method as one likely to prove useful for the purification of large quantities of the earths containing thoria in small quantity.

The earth from the thoria is of a salmon-yellow colour, its oxalate burns readily, and all tests were applied to discover lanthanum oxide, and only a very doubtful evidence of its presence was obtained. So that, of the three cerium metals, only didymium oxide remained to look for. A nitric acid solution gave the very well-known spectroscopic bands of that metal, but it was impossible to separate it by a chemical process. But by making use of the spectroscopic I think I have approximated to the proportion mixed with the oxides in the following manner:—

Quantitative Estimate of Didymium Oxide by its Absorption Bands.

Make solutions of the oxide of didymium of known strength, and place the solutions in tubes of uniform diameter. Phials of thin glass $1\frac{1}{2}$ c.m. diameter were used. Then take the oxides to be tested, dissolving a known quantity of the oxides in a solution of nitric acid, placing in a tube of the same size as those containing the didymium salt of known strength, compare the solution in the tubes before the spectroscope with the different didymium tubes, and it will be soon seen which one of these latter gives bands corresponding in intensity with the didymium bands in the solution of oxides that are tested; and knowing the exact proportions of oxide in the didymium tube, a good approximate result may be obtained.

I am now making an apparatus, using only one solution of didymium and simply varying at pleasure the thickness

of the solution. In this way I estimate that the mixed earthy oxides of samarskite contain less than 0.25 of didymium. As regards the principal portion of the earth separated from the yttria, I consider it as an oxide, or oxide of a new earth, for I cannot reconcile my mind to the idea that it is principally terbia. One of the earths present I call mosandrum, and M. Delafontaine has separated two, philippium and decipium.

Owing to the fact of bodily indisposition I have not been able to continue my researches on these earths.

For the complete quantitative analysis of samarskite, reference is made to labours previously made by myself and others,* with this difference, that in the earthy oxides there is 0.50 per cent of thoria, and the cerium referred to is not that oxide, but other mixed oxides.

NOTE ON A
METHOD OF PREPARING DIQUINOLINE.

By R. C. TRESIDDER.

THE following method was employed for obtaining diquinoline from quinoline:—

Quinoline was converted into its hydrochlorate by heating in a retort with the strongest hydrochloric acid, and distilling off the water. The hydrochlorate of quinoline was then heated with an equal weight of zinc chloride to a temperature of 350° C. for five or six hours, the retort being inverted. The product was transferred to a flask, and treated with strong solution of soda, added in sufficient quantity to re-dissolve the precipitate of zinc hydrate first formed. The mixture was then submitted to distillation with steam to remove unchanged quinoline, which distilled over, leaving a black oily liquid, which solidified on cooling. This black matter was washed with water, and then boiled with a large quantity of alcohol, and the solution filtered whilst hot. The filtrate was decolourised with animal charcoal, and again filtered hot. Diquinoline crystallised out on allowing the solution to cool, and was purified by re-crystallisation from alcohol. The yield was not large, but sufficient to render the method applicable to the production of diquinoline.

A DISTINCTIVE TEST FOR GALLIC ACID.

By SYDNEY YOUNG, D.Sc.

WHEN an aqueous solution of gallic acid is treated with a solution of potassium cyanide, a beautiful red colouration is produced, which, however, disappears after a short time if the liquid is not disturbed. The surface, however, remains coloured, and on tapping the test-tube in which the solution is contained, the superficial coloured portion is driven downwards into the colourless liquid below. If, now, the test-tube is shaken energetically, the colour reappears as at first, but, on standing, the liquid again becomes colourless. This alternate production and disappearance of the beautiful and characteristic red colour may be repeated as many as fifteen or twenty times, the solution finally attaining a permanent brownish yellow colour.

Pure tannic acid gives no colouration with potassium cyanide, but commercial tannic acid invariably contains a certain amount of gallic acid, and therefore the reaction is usually observed, though the colour is only feeble.

A sample of tannic acid, which gave a rather deep colouration with potassium cyanide, was dissolved in water, and to the strong solution about one-third of its volume of ether was added, and the whole shaken

* In the present instance I have calculated the amount on the basis of an atomic weight of the oxides of 116 (O=16).

* *Amer. Journ. of Science*, May, 1877.

vigorously. After standing, three layers were formed, as described by Guibourt (*Ann. Chem. Pharm.*, 48, 359).

After evaporation of the upper ethereal layer, the light yellow residue was dissolved in water and treated with potassium cyanide, when the deep red colour due to gallic acid was produced. The middle layer was found to contain a still larger quantity of gallic acid. A drop of the syrupy brown aqueous solution of tannic acid, which formed the lowest layer, when diluted with water and treated with potassium cyanide, gave a much feebler colouration than the original tannic acid. This process of purification was repeated four times, the gallic acid reaction, both in the case of the upper ethereal layer and the syrupy tannic acid solution, becoming weaker each time, until at last the cyanide produced no colouration whatever.

It thus appears that tannic acid free from gallic acid is not coloured by potassium cyanide, which reagent therefore affords by far the most convenient means of distinguishing between those two acids. Moreover, the presence of a very small quantity of gallic acid in tannic acid is indicated by this means.

University College, Bristol, July 12, 1883.

BEHAVIOUR OF CERTAIN ORGANIC COMPOUNDS WITH ROSANILINE SULPHUROUS ACID.

By G. J. SCHMIDT.

THE author's object is to ascertain whether the reaction first observed by H. Schiff, *i.e.*, that aldehyds give a violet colour to a solution of magenta previously decolourised by sulphurous acid, is characteristic of all and especially of the higher alkaloids, and by what other compounds, if any, such a colouration is produced. The reagent is best prepared by passing sulphurous acid into a dilute solution of a salt of rosaniline until the liquid merely retains a faint yellow colouration. It may be preserved for a long time in stoppered bottles. The substances examined by the author behaved as follows with the reagent:—

Acetaldehyd, paraldehyd, and propionaldehyd, even in traces, give an intense red-violet colouration. Iso-valeraldehyd and cænanthaldehyd give the colouration less readily. Chloral yields at once a fine colour, whilst chloral hydrate gives no reaction. Butyl-chloral and acroleine produce a violet colour on shaking. Furfural and benzaldehyd give the colour more readily. Cinnamaldehyd, furfur-acroleine, and furfur-crotonaldehyd give, first, an intense yellow colour, which soon changes to a violet-red. Salicylic aldehyd gives a fine red-violet colour, which, with cuminic aldehyd, appears only after some agitation. Formic acid gives no reaction. Even small quantities of acetone on shaking produce a violet-red colour, but aceto-phenon and benzo-phenon had no action. Among the sugars, glucose, levulose, lactose, and saccharose were tried, and had no effect. Methylic and ethylic alcohols on shaking gave a faint violet colour; propylic and iso-propylic alcohols gave a scarcely perceptible tint. The alcohols with a higher proportion of carbon, the glycols, phenols, and quinone had no effect on the reagent.

Hence it appears that the reaction is characteristic of the aldehyds in general, but that it is also produced by certain simply-composed bodies of the fatty series which stand nearest the aldehyds.—*Zeitschrift für Anal. Chemie.*

Appointment.—Mr. A. Humboldt Sexton, Science Master at the Wedgwood Institute, Burslem, has been appointed Teacher of Chemistry, Physics, and Metallurgy at the Manchester Technical School.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Professor of Chemistry and Physics in the University of Cincinnati.

SILVER, POTASSIUM, SODIUM, CHLORINE, BROMINE, IODINE, AND SULPHUR.

(Continued from p. 19).

IN 1842 Marignac† published two determinations, with these results from 100 KCl:—

	192.33
	192.34
Mean, corrected for	—
weighing in air ..	192.26 ± 0.003

In 1846 Marignac‡ published another set of results, as follows. The weighings were reduced to vacuum. The usual ratio is in the third column.

17.034 grms. KCl gave	32.761 AgCl	192.327
14.427 "	27.749 "	192.341
15.028 "	28.970 "	192.374
15.131 "	29.102 "	192.334
15.216 "	29.271 "	192.370

Mean, 192.349 ± 0.006

Three estimations of the same ratio were also made by Maumené||, as follows:—

10.700 grms. KCl gave	20.627 AgCl	192.776
10.5195 "	20.273 "	192.716
8.587 "	16.556 "	192.803

Mean, 192.765 ± 0.017

The three series of ten experiments in all foot up thus:—

Marignac, 1842	192.260 ± 0.003
" 1846	192.349 0.006
Maumené	192.765 0.017

General mean, 192.294 ± 0.0029

These figures show clearly that the ratio which they represent is not of very high importance. It might be rejected altogether without impropriety, and is only retained for the sake of completeness. It will obviously receive but little weight in our final discussion.

In estimating the atomic weight of bromine the earlier experiments of Balard, Berzelius, Liebig, and Löwig may all be rejected. Their results were all far too low, probably because chlorine was present as an impurity in the materials employed. Wallace's determinations, based upon the analysis of arsenic tribromide, are tolerably good, but need not be considered here. In the present state of our knowledge, Wallace's analyses are better fitted for fixing the atomic weight of arsenic, and will, therefore, be discussed with reference to that element.

The ratios with which we now have to deal are closely similar to those involving chlorine. In the first place there are the analyses of silver bromate by Stas.§ In two careful experiments he found in this salt the following percentages of oxygen:—

20.351
20.347

Mean, 20.349 ± 0.0014

* Smithsonian Miscellaneous Collections. "The Constants of Nature."

† *Ann. Chem. Pharm.*, 44, 21. 1842.

‡ "Berzelius's *Lehrbuch*," 5th edition, vol. iii., pp. 1192, 1193.

|| *Ann. d. Chim. et d. Phys.* [3], 18, 41. 1846.

§ "Aronstein's Translation," pp. 200-206.

There are also four analyses of potassium bromate by Marignac.* The salt was heated, and the percentage loss of oxygen determined. The residual bromide was feebly alkaline. We cannot place much reliance upon this series. The results are as follows:—

28.7016
28.6496
28.6050
28.7460

Mean, 28.6755, ± 0.0207

When silver bromide is heated in chlorine gas, silver chloride is formed. In 1860 Dumas† employed this method for estimating the atomic weight of bromine. His results are as follows:—In the third column I give the weight of AgBr equivalent to 100 parts of AgCl.

2.028 grms. AgBr gave	1.547 AgCl	131.092
4.237 "	3.235 "	130.974
5.769 "	4.403 "	131.024

Mean, 131.030 ± 0.023

This series is evidently of but little value.

But the two ratios upon which, in connection with Stas's analyses of silver bromate, the atomic weight of bromine chiefly depends are those which connect silver with the latter element directly and silver with potassium bromide.

Marignac,‡ to effect the synthesis of silver bromide, dissolved the metal in nitric acid, precipitated the solution with potassium bromide, washed, dried, fused, and weighed the product. The following quantities of bromine were found proportional to 100 parts of silver:—

74.072
74.055
74.066

Mean, reduced to a vacuum standard .. 74.077 ± 0.003

Much more elaborate determinations of this ratio are due to Stas.¶ In one experiment a known weight of silver was converted into nitrate, and precipitated in the same vessel by pure hydrobromic acid. The resulting bromide was washed thoroughly, dried, and weighed. In four other estimations the silver was converted into sulphate. Then a known quantity of pure bromine, as nearly as possible the exact amount necessary to precipitate the silver, was transformed into hydrobromic acid. This was added to the dilute solution of the sulphate, and, after precipitation was complete, the minute trace of an excess of silver in the clear supernatant fluid was determined. All weighings were reduced to a vacuum. From these experiments, taking both series as one, we get the following quantities of bromine corresponding to 100 parts of silver:—

74.0830
74.0790
74.0795
74.0805
74.0830

Mean, 74.081 ± 0.0006

Combining this with Marignac's result, 74.077, ± 0.003 , we get as a general mean the value 74.0809, ± 0.0006 .*

The ratio between silver and potassium bromide was first accurately determined by Marignac.† I give with his weighings, the quantity of KBr proportional to 100 parts of Ag:—

2.131 grms. Ag =	2.351 KBr	110.324
2.559 "	2.823 "	110.316
2.447 "	2.700 "	110.339
3.025 "	3.336 "	110.283
3.946 "	4.353 "	110.314
11.569 "	12.763 "	110.321
20.120 "	22.191 "	110.293

Mean, corrected for weighing in air, 110.343 ± 0.005

Stas,‡ working in essentially the same manner as when he fixed the ratio between potassium chloride and silver, obtained the following results:—

110.361
110.360
110.360
110.342
110.346
110.338
110.360
110.336
110.344
110.332
110.343
110.357
110.334
110.335

Mean, 110.3463 ± 0.0020

Combining this with Marignac's mean result, 110.343 ± 0.005 , we get a general mean of 110.3459 ± 0.0019 .

The ratios upon which we must depend for the atomic weight of iodine are exactly parallel to those used for the determination of bromine.

To begin with, the percentage of oxygen in potassium iodate has been determined by Millon.¶ In three experiments he found:—

22.46
22.49
22.47

Mean, 22.473 ± 0.005

Millon also estimated the oxygen in silver iodate, getting the following percentages:—

17.05
17.03
17.06

Mean, 17.047 ± 0.005

The analysis of silver iodate has also been performed with extreme care by Stas.§ From 76 to 157 grammes were used in each experiment, the weights being reduced to a vacuum standard. As the salt could not be prepared in an absolutely anhydrous condition, the water expelled in each analysis was accurately estimated and the neces-

* O. W. Huntington, in his paper upon the atomic weight of cadmium (*Amer. Acad. Proc.*, 1881), gives three analyses and three syntheses of silver bromide. These give a mean value of—

Ag : Br : : 100 : 74.064.

This figure I record here in order that other chemists may not overlook the work of Mr. Huntington, although it came out too late for use in my own calculations.

† E. Mulder's "Overzicht," p. 116; Berzelius's *Jahresberichte*, 24, 72.

‡ "Aronstein's Translation," pp. 334-347.

¶ *Annales de Chim. et de Phys.* [3], 9, 400. 1843.

§ "Aronstein's Translation," pp. 179-200.

* See E. Mulder's "Oversigt," p. 117; or Berzelius's *Jahresberichte*, 24, 72.

† *Ann. Chem. Pharm.*, 113, 20.

‡ E. Mulder's "Overzicht," p. 116; Berzelius's *Jahresberichte*, 24, 72.

¶ "Aronstein's Translation," pp. 154-170.

sary corrections applied. In two of the experiments the iodate was decomposed by heat, and the oxygen given off was fixed upon a weighed quantity of copper heated to redness. Thus the actual weights, both of the oxygen and the residual iodide were obtained. In a third experiment the iodate was reduced to iodide by a solution of sulphurous acid, and the oxygen was estimated only by difference. In the three percentages of oxygen given below the result of this analysis comes last. The figures for oxygen are as follows:—

16.976
16.972
16.9761

Mean, 16.9747 ± 0.0009

This, combined with Millon's series above cited, gives us a general mean of 16.9771 ± 0.0009 .

(To be continued.)

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvi., No. 1, July 2, 1883.

The Compressibility and the Liquefaction of Gases.

—J. Jamin.—This paper cannot be usefully abstracted without the accompanying diagram.

Action of Hydrochloric Acid upon Stannous Sulphide.—A. Ditte.—Dry hydrochloric acid does not attack crystalline tin sulphide at ordinary temperatures, but on applying heat the reaction begins with formation of hydrogen sulphide and stannous chloride. Liquid hydrochloric acid attacks crystalline tin sulphide, even at ordinary temperatures, but the degree of concentration of the acid plays a great part in the phenomenon. If a current of hydrogen sulphide is passed into stannous chloride, the precipitate has not always the same aspect. If hydrochloric acid is brought in contact with an excess of tin sulphide, or if a current of hydrogen sulphide is passed into a solution of stannous chloride, an equilibrium is soon established in the liquids. It was examined whether in concentrated acid solutions there may be formed a hydrochlorate of stannous chloride, the decomposition of which by hydrogen sulphide is not effected in the same manner as that of the chloride, but it is not the case. Hydrochloric acid in the cold attacks hydrated stannous sulphide more rapidly than the anhydrous sulphide. With tin selenide the same phenomena are obtained as with the sulphide. The telluride is attacked by dry hydrochloric acid with the aid of heat, but it is not acted upon by the liquid acid, even in the most concentrated solution.

Fusibility of Salts.—E. Maumené.—The author has examined the melting-points of potassium and sodium nitrates mixed in various proportions, and finds that the figures given by calculation differ very widely from those obtained by actual experiment. The latter results are always lower, sometimes by as much as 94° .

A New Method for the Determination of Urea.—L. Hugouenq.—The author filters the urine over animal charcoal, dilutes with water, and heats it to 140° in a sealed tube. The ammonium carbonate formed is then determined by titration, using as indicator the coal-tar colour known as *orange* No. 3. The figures obtained agree very fairly with those given by the hypobromite process. This method may be applied to albuminous urines if the albumen is previously coagulated by heat.

It is not available in such as contain glucose or magnesia in notable quantities.

Examination of Corpuscles held in Suspension in Water.—Eug. Marchand.—The author recommends, as a method not new in principle, but which has never yet been put in practice, an optical examination of waters. He places the sample in a clear glass bottle, wrapped in black paper, having two rectangular apertures opposite to each other, one of which serves for the admission of a beam of light, whilst the observer is stationed at the other. When the liquid is optically pure, the light passes without hindrance, but if it is charged, however slightly, with suspended particles, they become visible. M. Marchand calls attention to the existence of certain organisms of about 0.002 metre in diameter, which he considers have hitherto escaped observation.

Justus Liebig's Annalen der Chemie,
Band 218, Part 3.

Communications from the Chemical Laboratory of the University of Jena.—These consist of a memoir by Dr. Fr. Stengel, on certain salts of three disulpho-dialkyl-benzoic acids; a paper by Dr. J. Engelcke, on two disulpho-dialkyl-isæthionic acids, and on attempts to prepare analogous compounds with benzol-sulphonic acid; an account of methyl-sulphonic acid, by Dr. Nithack; and an essay by Prof. Geuther, on the constitution of the double compounds of salts of the sulphonic acids with neutral sulphuric ethers, on the constitution of the sulphates, and on the reason of their dimorphism.

Specific Volumes of the Esters of the Fatty Series.—Emil Elsässer.—The author gives his results in the form of tables. He describes and figures the "dilatometer" with which he performed his experiments, and which was specially constructed by Geissler, of Bonn.

Ketones of the Aromatic Series (Second Treatise).—W. Staedel.—The author here gives an account of tetra-nitro-diphenyl-methan, of tetra-nitro-benzo-phenon, of the reduction of the former of these two compounds, of diamido-benzo-phenon, the reduction of dinitro-benzo-phenon from benzo-phenon, β -diamido-benzhydryl, and of dioxy-benzo-phenon.

Saccharone and Saccharine.—H. Kiliani.—The author describes a number of the salts of saccharone and its behaviour and that of saccharine with hydriodic acid.

Communications from the Chemical Laboratory of the University of Lemberg.—These consist of a paper by P. Wispek and R. Zuber, on the action of allyl-chloride upon benzol in presence of aluminium chloride, and a memoir, by Julian Schramm, on the action of bromine upon aromatic hydrocarbons with a saturated lateral chain.

Bulletin de la Société Chimique de Paris.
No. 12, June 20, 1883.

"Disinfection" of Alcohol of a Bad Flavour by Electrolysis.—Laurent Naudin.—A bulky paper, requiring the three accompanying illustrations. The inaccurate use of the word "disinfection" is to be regretted.

Penta-chloric Acetone.—Ch. Cloëz.—The author has prepared this compound by two distinct methods: the action of chlorine upon a solution of citric acid at 100° , and by that of dry chlorine upon well-dried acetone under exposure to the sun.

Formation of Certain Sulphides by Pressure, and Considerations Concerning the Allotropic States of Phosphorus and Carbon.—W. Spring.—This paper will be inserted at length.

Researches on the Metallic Derivatives of the Amides. Means of Distinguishing a Monamide from a Diamide.—H. Gal.—Already noticed.

Preparation of Propyl-iodide.—M. Chancel.—The

author introduces 127 grms. iodine, 60 grms. propylic alcohol, and 10 grms. of amorphous phosphorus into a litre flask, which is at once connected with a reflux condenser, well supplied with cold water. When the reaction is over, heat is applied for an hour, and the mixture is then distilled. Water is added to the distillate, and the precipitated ether is decanted. The product is decolourised by agitation with a very dilute alkaline solution, washed with water, decanted again, dried by digestion for twenty-four hours with powdered chloride of calcium, and rectified. The yield is about 90 per cent of the theoretic quantity.

Cosmos Les Mondes.

No. 9, June 30, 1883.

Discovery of Electro-magnetism.—Dr. D. Tommasi. —The author produces a passage from the *Ristretto dei Foglietti Universali*, of August 3, 1802, from which it appears that J. D. Romagnosi had observed the deflection of the magnetic needle occasioned by a galvanic current in the month of May of the same year. The same passage is quoted in Hœfer's "Histoire de la Physique et de la Chimie," p. 298.

MISCELLANEOUS.

Conversazione of the Chemical Societies.—In connection with the Annual Meeting, held in London last week, of the Society of Chemical Industry, Dr. W. H. Perkin, President of the Chemical Society, Sir Frederick Abel, C.B., D.C.L., retiring President of the Society of Chemical Industry, and Dr. Odling, President of the Institute of Chemistry, invited the Members of the three societies to a conversazione on Friday evening at the Galleries of the Institute of Painters in Water Colours, and the Prince's Hall, Piccadilly. The rooms were crowded, and among those present were Admiral Brandreth, Comptroller-General of the Navy, General Sir Collingwood Dickson, President of the Ordnance Committee, General Sir Charles Nugent, General Crawford, General Smyth, Sir Henry Leifroy, F.R.S., Colonel Webbe, C.B., Colonel Donnelly, Colonel Malcolm, R.E., C. B., the President of the Royal Society, Dr. J. H. Gilbert, Professors Adams, Dewar, Guthrie, Hughes, Armstrong, Warrington Smyth, Ayrton, Noel Hartley, Huntingdon, Clifton, and Bedson; Mr. A. M. Chance, Mr. Charles Tennant, Mr. E. K. Muspratt, Mr. John Pattinson, Mr. Watson Smith, Mr. C. E. Groves, Mr. James Mactear, Mr. J. M. Thomson, and Mr. W. Crookes.

Hoskins's Hydrocarbon Blowpipe and Furnaces.—For the conduction of metallurgical operations on a small scale, as the testing of smelting charges and such like, or the processes of cupellation and scorification of the assayer, the furnaces and blowpipe apparatus, patented and manufactured by Mr. William Hoskins, of Chicago, in which light mineral oils are used as a source of heat, seem to offer some advantages over the ordinary small gas furnaces in use among assayers, especially in point of portability. The arrangement for producing the flame consists of a reservoir, into which the volatile oil is forced by means of a force-pump, the pressure of the compressed air inside the vessel being sufficient to send the liquid through the tubes of the burner, when it is vapourised by heating the burner, and finally issues from a fine orifice as a highly heated gas, the flame produced being directed into an opening in the side of the furnace containing the crucible or muffle. Gasoline, of 74°, is recommended as being the best fuel, and in ordinary effective operations one gallon is said to last eight hours. The patentee claims for his furnace the merits of performing the ordinary metallurgical operations quicker, better, and with greater accuracy than any other. Starting with the furnace cold, it will melt one-half pound of cast-iron in fifteen minutes or one pound of brass in eleven minutes.

Association of Science and Art Teachers.—President: Professor T. H. Huxley, LL.D., President of the Royal Society.—At a well attended meeting of science and art teachers, held on Saturday, June 2nd, at the Manchester Technical School and Mechanics' Institution, the Association was formally inaugurated by the appointment of an Executive Board, the adoption of Rules, enrolling of Members, and other business. The Association is established to effect the general advancement of the profession of science and art teaching, by securing improvements in the schemes of study and advances in the standard of teaching, together with the establishment of more satisfactory relations between teachers and the Science and Art Department, the City and Guilds of London Institute, and other public authorities, and by endeavouring to secure the adoption of such regulations as are conducive to educational progress. It is not possible to state here all the directions in which useful action may be taken. The successful history of the National Union of Elementary Teachers will, however, suggest the general lines of constitution, organisation, and procedure, applicable to this Association. The Executive will be glad to receive and consider any suggestions for the improvement or advantageous development of the various schemes of instruction in which members are interested, and will take such action as may appear desirable under the circumstances. It will collect such information as may be of service to teachers professionally, and it will endeavour by constant watchfulness to advance the status and material interests of science and art teachers in all directions. The Executive contemplate the formation of affiliated district unions in various parts of the kingdom. As the effectiveness of the Association will greatly depend upon its strength, which should as far as possible be augmented during the summer months of the present year, the Committee respectfully urge upon teachers to become members at once. The subscription has been fixed at 2s. 6d. per annum. The next General Meeting will be held on Saturday, September 1st, at 7.30 p.m. All communications should be addressed to the Hon. Sec., W. E. Crowther, Technical School and Mechanics' Institution, Manchester.

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THE CHEMICAL NEWS.

VOL. XLVIII. No. 1235.

A NOTE ON A PECULIAR EXCRETORY PRODUCT, FOUND IN THE "LIVER" OF *SEPIA OFFICINALIS*.

By A. B. GRIFFITHS, F.C.S.,
Member of the Liverpool Association of Science and Arts;
Medallist in Chemistry and Botany, &c.

WHEN dissecting a fresh *Sepia officinalis* (the cuttle-fish), a short time ago I noticed a number of small roundish bodies of a dark colour in the substance of the so-called "liver" of this animal. I have noticed them before in the "liver" of the *Sepia*, but they are not of constant occurrence; perhaps they may be abnormal. I have made a chemical examination of them as far as possible with such small quantities for experimentation. These dark coloured bodies (about 1-12th of an inch in diameter) were only found in the anterior part of the organ. Under the microscope they appear to be aggregations of crystal-like bodies; the forms recognised were octohedra, rhombohedra, and cubes. On detaching several of these roundish bodies from the "liver" and heating them on a platinum capsule, they were first converted into carbonaceous masses, and on ignition left a microscopic amount of ash. This experiment shows that these crystalline bodies are of an organic nature and are not true crystals of a mineral composition. The minute quantity of ash left on ignition when examined spectroscopically gave the characteristic green lines of copper. On separating these roundish bodies from the "liver" of the *Sepia*, teasing them out with needles, mounting them in weak glycerin, and then treating with certain reagents under the microscope, the following reactions were observed:—

Microscopic Reactions.

(a). On running in between the slide and the cover-slip a solution of iodine in potassium iodide; these pseudo-crystals (if I may so term them) were stained brown.

(β). On running in dilute potash solution the pseudo-crystals disappeared.

(γ). When treated with Millon's reagent (mercuric nitrate) and the slide heated over a spirit-lamp, a red colour was produced.

(δ). When treated with concentrated nitric acid a yellow colouration was observed due to the formation most probably of the xanthoproteic acid of Mulder, for on running in the dilute potash this yellow colour turned red.

Chemical Reactions.

(1). When several of these roundish bodies were boiled in a small test-tube with pure hydrochloric acid a blue colour was formed, which ultimately changed to violet, and then to brown.

(2). On heating a quantity of these bodies with solid caustic potash in a test-tube, ammonia was evolved.

(3). On dissolving these bodies in a solution of potash, and then boiling with lead hydrate dissolved in dilute potash, lead sulphide was formed. From these experiments and observations I come to the conclusion that these pseudo-crystals have the composition of a *bumin* inasmuch as they contain nitrogen and sulphur proved by the last two experiments; and the microscopic reactions all go to confirm that these excretory products are of an albumenoid character. I tried to make a combustion analysis of these bodies, but had too small a quantity to operate upon for a successful issue. I submit that these albuminous crystals are true excretory products of this so-called

"liver" of *Sepia officinalis*. From the chemical composition of these bodies found, I think these investigations give further evidence in favour of the supposition that this so-called "liver" of the Cephalopod is not a true liver like that of the higher animals, but is "pancreatic in function," for we know that in the higher animals albumenoids are decomposed in the liver, while the fluid of the pancreas is one of the few secretions which contains albumin in a soluble form. Long ago Tiedemann and Gmelin in some cases found the proportion of albumin to amount to 4 per cent of the entire fluid of the pancreas. Therefore, if albuminous crystals are at times to be excreted by, and found in, the substance of this so-called "liver," I think the fluid contained in this organ must contain albumin as a constituent, and is in fact a true pancreas, or digestive organ. These albuminous crystals are most likely similar to the crystalloids (which are of a protein nature) found in certain cells of plants.

As I stated at the beginning of the paper these pseudo-crystals are not of constant occurrence in this organ; if they are abnormal or the products of disease, all I can say is they appear to be deposited from the secretion of this organ, showing that it contains albumin, and from this circumstance I think the conclusion to be drawn is that this organ is more of a pancreas than a liver.

This albumin (or "sanguigenous body" as Liebig liked to call it) found in pseudo-crystalline aggregations in the anterior part of the *Sepia*'s "liver" yielded, as I stated before, on ignition a microscopic ash, which, when treated with pure hydrochloric acid and examined with the spectroscope, gave most prominently the copper spectrum. The copper must have been derived from the blood of the animal, for it is well-known that the blood of *Sepia officinalis* contains copper.

The dark colour of these crystalloid aggregations which were alluded to at the commencement of the paper was, under the microscope, seen to be a very thin and superficial covering, and may be some colouring matter—probably the same chlorophyll pigment which Dr. C. A. MacMunn described in a paper which was read before the Royal Society on the 5th of April last; he having found it in the so-called "liver," &c., of the Mollusca, Arthropoda, Echinodermata, and in the invertebrata generally.

LAVOISIER AND MODERN SCIENCE.

By G. F. RODWELL.

THIS memoir, which we find in the *Revue Scientifique* for May 26, 1883 (3e Série, 3e Année, No. 21), is of such grave importance for the history of chemical science that it fitly requires careful notice. It is nothing less than an able and successful vindication of the scientific merit of Lavoisier, and a refutation of certain charges which have been commonly brought against him. He has been commonly and very emphatically accused of appropriating the discoveries of his contemporaries. Thus Dr. Thomson, in his well known "History of Chemistry," states that Lavoisier claimed the discovery of oxygen gas for himself, but that his claim merits no notice, as Priestley had shown him the process in 1774, "long before the date assigned by Lavoisier to his pretended discovery." It is said that, though he had been informed by Cavendish of the composition of water, he nevertheless sought to appropriate this discovery. On this subject James Watt, who also puts in a claim to have first observed the compound nature of water, wrote in 1784:—"Immediately after the appearance of my memoir on this subject Dr. Blagden explained my theory to M. Lavoisier, at Paris, and shortly after M. Lavoisier discovered it himself, and presented a memoir on the subject to the Academy of Sciences. Since then Mr. Cavendish presented to the Royal Society a memoir on the same subject without making mention of me. The one is a French financier,

whilst the other belongs to the illustrious house of Cavendish. The great sometimes commit paltry actions." It will not be deemed out of place if we pronounce it utterly inconceivable that a man so regardless of the honour accruing from his own discoveries—and who often did not think it worth while to make them known—should appropriate those of others.

Brande seems to apologise for the sins of Lavoisier as due to haste and inadvertence, and Liebig omits his name among the founders of the new era in chemistry.

Having thus summarised the principal charges against Lavoisier, we turn to Mr. Rodwell's reply. He points out the erroneous nature of the assumption that Lavoisier first referred to the existence of oxygen and the composition of air and of water in his "*Traité de Chimie*," published in 1789. Hence many authors have supposed that his experiments on this subject had then been but recently made. But he mentions oxygen and the nature of the air twelve years earlier, in a paper read before the Academy May 3rd, 1777, and bearing the title "On the Respiration of Animals, and on the Changes which Air Undergoes in Passing through their Lungs." It further appears that he had obtained oxygen, by means of the red precipitate of mercury, more than two-and-a-half years before the date of the paper. This brings us to some time in the year 1774! Now Priestley did not obtain oxygen until August in the same year, so that the difference in date is very trifling.

Dr Thomson, in his "*History of Chemistry*," criticising Lavoisier's "*Opuscules Physiques et Chimiques*," published, it must be remembered, early in 1774, and bearing date December 3rd, 1773, says:—"Nothing in these researches indicates that Lavoisier suspected air to be a mixture of two distinct fluids, one of which only intervenes in combustion and calcination. Yet Priestley had already deduced this fact from his own experiments, and Priestley had discovered the existence and the characteristic properties of oxygen gas." But in the "*Opuscules*" Lavoisier shows distinctly that air is composed of two fluids, one of which is absorbed during calcinations. This announcement was not merely prior to Scheele's deduction of the composition of air from his own experiments, and even eight months before Priestley obtained oxygen from the red oxide of mercury. "Thus," says Mr. Rodwell, "the accusations of Dr. Thomson fall and disappear one after the other."

It has been often said that Lavoisier had the habit of using the ideas of others without acknowledgment. Mr. Rodwell, on examining Lavoisier's original memoirs, finds that he was constantly and scrupulously careful in his referring to the works of other authors. Thus in 1776 Lavoisier wrote:—"I will begin by informing the public that a part of the experiments contained in this memoir do not in strictness belong to me; perhaps, correctly speaking, there is none of them of which M. Priestley might not claim the original idea, but as the same facts have led us to conclusions diametrically opposite, I hope that if anyone reproaches me for having borrowed proofs from the works of this celebrated physicist my claim to the conclusions will not be contested."

In the same year, in a treatise on muriatic acid, ammonia, and sulphurous acid, he writes—"The experiments of which I have just given an account belong almost all to Dr. Priestley; I have merely the merit of having repeated them with care, and above all of having arranged them in an order suitable for showing their consequences."

Again, in 1777, in a memoir on "Respiration," Lavoisier writes that Priestley, "by means of highly ingenious, very delicate, and novel experiments," has endeavoured to prove that respiration phlogisticates the air like calcination.

The passages just quoted are certainly not couched in the language of a systematic plagiarist,—an appropriator of the merits of others.

But we must pass on to the main accusation. What foundation have the detractors of Lavoisier for maintaining

that he laid any dishonest claim to the discovery of oxygen? He writes in his "*Traité de Chimie* :—This air which M. Priestley, M. Scheele, and myself have discovered almost simultaneously."

Further, in 1782, in a work entitled "*Sur un Moyen d'Augmenter considérablement l'Act on du feu et de la Chaleur dans les Opérations Chimiques*," Lavoisier, speaking of oxygen, says:—"This gas, which M. Priestley discovered about the same time as I myself, and indeed, I believe, before me." Here, then, Lavoisier, so far from claiming anything not his own, explicitly admits Priestley's priority in all that was justly his due. For we must bear in mind that for some months Priestley was completely ignorant of the nature of the gas which he had discovered. In October, 1774, and even later, he believed that it was ordinary air containing "nitrous corpuscles." Even to his death he remained a determined partisan of the phlogiston theory. Consequently he never rightly understood the part played by oxygen, whether in the chemistry of nature or of art.

Having arrived at this point, Mr. Rodwell raises the question, what is the true sense of the words "discovery" and "discoverer"? Is the discoverer the man who first sees or produces a new fact, a novel phenomenon, or rather the man who first recognises its nature and its relations with other facts? Mr. Rodwell reminds us that nearly 300 years before Priestley, Eck, of Sulzbach, noted the increase of weight of mercury when submitted to oxidation—or, as it was then called, to calcination—and on submitting this "calx" to a higher temperature he obtained "a spirit,"—evidently oxygen gas. Hence Priestley did not find the ground entirely unoccupied.

Our author calls also to mind that Robert Hooke, and still more Robert Mayow, came much closer upon the theories of Lavoisier than ever did Priestley. If Hooke's twelve propositions on combustion had not been buried in a book on microscopic discoveries little likely to be studied by chemists, and if Mayow had not died at the early age of 34, it is not improbable that the Phlogistian system might never have originated, and that Lavoisier, starting on a higher plane, might have been able to devote his splendid genius to yet more important tasks than those which fell to his lot. Be this as it may, we cannot but rejoice to find the reputation of this illustrious chemist effectually cleared from the charges of plagiarism which have been brought against him. Mr. Rodwell observes, in conclusion, that it would be impossible to compare two minds more fundamentally opposite than Lavoisier and Priestley. "The latter experimented at random and made his discoveries, so to speak, by accident. Lavoisier worked methodically, and his results often confirmed his theories. Priestley was an obstinate upholder of phlogiston, and refused to abandon it long after its falsehood had been recognised by the *savants* of Europe. Lavoisier, by the most beautiful series of deductions, overturned this theory, which his predecessors had so long accepted, and on its ruins he erected a monument henceforth imperishable."

Researches on the Destruction and Utilisation of the Bodies of Animals Dead of Contagious Maladies, and especially of Splenic Fever.—A. mé Girard.—Sheep dead of "charbon," entire and still covered with their fleeces, were placed in a wooden vat lined with lead, and filled to one-third with sulphuric acid at sp. gr. 1.625°. In about 24 to 48 hours, without the application of heat, the carcasses disappeared entirely, the specific gravity of the acid being reduced to 1.39°. The acid is capable of thus dissolving more than two-thirds of its weight of animal matter. The black, acid, and nitrogenous syrup thus formed has been examined by one of the most skilful assistants of M. Pasteur (M. Roux), who has proved, both by inoculation and by culture, that no germ of the disease survives. The acid contains 0.8 per cent of nitrogen and 0.5 of soluble phosphoric acid, and may be advantageously used in the manufacture of superphosphate.—*Comp. Rend.*

ON SAMARIUM.

By P. T. CLÈVE.

IN 1878 M. Delafontaine found that the didymium of samarskite is accompanied by a new element with a peculiar absorption-spectrum and a higher atomic weight. He gave to this element the name of decipium. The following year M. Lecoq de Boisbaudran isolated in very small quantity, from the fractions of the earths of samarskite rich in didymium, an oxide, the absorption-spectrum of which he minutely described, the metallic radicle of which has been named *samarium*.

In 1880 M. Delafontaine published his researches on decipium, and shortly afterwards M. Marignac published his examination of the earths of samarskite which accompany terbium. He described under the symbol $Y\beta$ an oxide, the absorption-spectrum of which agrees with the spectrum of samarium, the maximum atomic weight of the metal being 99.6 or 149.4 (the oxide being RO or R_2O_3). The salts are characterised by their yellow colour. Decipium, according to M. Delafontaine, yields colourless salts, and the atomic weight of the metal is 144 (RO) or 171 (R_2O_3), which differs considerably from the figures of M. Marignac.

Subsequently M. Delafontaine found that his decipia of 1878 was a mixture of an oxide with the spectrum of samarium, for which he adopts the name samarium, and another oxide without absorption-spectrum, for which he retains the name of decipium. The metal of the former oxide has the atomic weight 101 (SmO , or $151.5 Sm_2O_3$), and that of the latter 114 (DpO , or $171 Dp_2O_3$). From these two oxides the author has obtained samarium oxide in a state of purity, that is to say, free from didymium and of a constant molecular weight. The raw material was an oxide of didymium, obtained from the orthite of Arendal, from cerite, gadolinite, and keilhauite. He separated the samarium oxide from the didymium by repeated precipitations with dilute ammonia, operations which required the continuous work of five months.

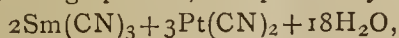
The oxide of samarium thus obtained was still not pure. It contained terbia and an oxide of a higher atomic weight, probably the $Y\alpha$ of M. Marignac. It was necessary to submit it to repeated precipitations with potassium sulphate, until the oxide remaining in solution had the same molecular weight as the precipitated.

Taking for the oxide the formula Sm_2O_3 , which agrees perfectly with its chemical characters, six experiments with different fractions gave atomic weights ranging from 149.940 to 150.120. The mean of these determinations is 150.021.

Samarium oxide is white with a scarcely perceptible yellowish tint. It dissolves readily in acids, and gives salts of a topaz colour. The hydrate is white and gelatinous: it is a stronger base than yttria and terbia, but less powerful than didymium oxide. The author has prepared and analysed the chloride $SmCl_3 \cdot 6H_2O$ in large deliquescent crystals; the chloro-platinate,—



forming long orange prisms; the platino-cyanide—



yellow prisms with a bluish reflection; the nitrate, $Sm_3NO_3 \cdot 6H_2O$, pale yellow prisms; the acetate, $Sm_3C_2H_3O_2 \cdot 4H_2O$, in short prisms; the sulphate, $Sm_2SO_4 \cdot 8H_2O$, is much less soluble than the corresponding salt of didymium; the seleniate, $Sm_3SeO_4 \cdot 8H_2O$, resembles the sulphate, but is readily soluble; the double potassium sulphate is a white powder, sparingly soluble, $2Sm_2SO_4 + 9K_2SO_4 + 3H_2O$; the double ammoniacal sulphate, $Sm_2SO_4 + (NH_4)_2SO_4 + 8H_2O$, forms small distinct crystals. The selenite, $Sm_2O_3 \cdot O_{3.4}SeO_2 + 5H_2O$, was obtained by the action of selenious acid upon the acetate. It is a precipitate consisting of microscopic needles. The oxalate, $Sm_2C_2O_4 = 10H_2O$, is a crystalline powder. In its chemical characters samarium

approaches more to didymium and less to the yttria metals. The composition of its salts is the same as that of the salts of didymium. The formulæ of the chloro-platinate, of the ammoniacal sulphate, and of the selenite place the formula Sm_2O_3 beyond all doubt.—*Comptes Rendus*.

A SIMPLE METHOD OF CORRECTING THE WEIGHT OF A BODY FOR THE BUOYANCY OF THE ATMOSPHERE WHEN THE VOLUME IS UNKNOWN.

By JOSIAH PARSONS COOKE.

It is a familiar fact that in the usual method of accurate weighing the buoyancy of the atmosphere produces a sensible effect whenever the volume of the load differs materially from that of the equipoise. But, as in all ordinary processes of chemical analysis the analyst deals solely with relative weights, the presence of a perfectly dry atmosphere does not influence his results, unless the conditions of temperature and pressure have changed between the successive weighings: and even then the effect is insignificant in most cases. Still when the volume of the vessel weighed differs from that of the weights by a little as 25 cubic centimetres—for example in weighing the absorption tubes used in "organic analysis"—the error caused by variations in the density of the atmosphere may be sufficient to seriously impair the accuracy of the result.

In weighing large vessels—as in determining the density of a gas—the effect of any variation of buoyancy is eliminated by the well known effects of calculating the results. But the formulæ usually given for that purpose involve as known quantities the volume of the vessel, the volume of the weights, the density of the air under the standard conditions, as well as the temperature and pressure at the moment of the several observations; and since the calculations are somewhat complex, and the required data not always readily obtained, the formulæ are seldom applied unless the volume of the load is quite large. Moreover in these formulæ the effect of each factor can not readily be traced, and most analysts are probably not aware of the extent to which their weighings may be influenced by changes in the density of the air due to variations of temperature and pressure. In seeking to fix the weight of certain absorption-tubes (in connection with my work on the revision of the atomic weights) I have been led to a method of correcting the weights of such tubes for variations of buoyancy: which, while it does not involve the determination of any data except the temperature and tension of the air in the balance-case, and is as simple in its application as the calibration of a flask, also gives a clear conception of the effect of each variable on the weight.

It is assumed that the air of the balance-case is dry; and with one of Becker's balances I have not been able to trace any effect on the weight of a glass vessel from variations of hygrometric condition when two open dishes of sulphuric acid (three inches in diameter) were kept in the case, which has a volume of about 37 cubic decimetres. Under such conditions the only causes which sensibly modify the weight of a small glass vessel (like a closed potash bulb-tube) are the variations of temperature and pressure. The relative effect of these two variables will appear from the following considerations, which suggested the method I am to describe. If we assume thirty inches as the standard of barometric pressure it is obvious that the variation of each tenth of an inch from this standard will determine a change of 1.300th in the resultant effect of the buoyancy of the air on the load and its equipoise. Again, if we assume 27° C. as our standard of temperature—that is 300° on the so-called "absolute scale"—then according to the law of Charles the variation of each

degree from this point will also cause a change of 1-300th in the same resultant. In other words, counting from these standards, a variation of one degree in the centigrade thermometer indicates the same effect on the density of the atmosphere—and therefore on its buoyancy—as the change of one-tenth of an inch in the mercurial barometer. In our climate the barometer changes slowly, and its fluctuations do not ordinarily exceed one inch. On the other hand the balances in our chemical laboratories are liable to rapid variations of temperature which often exceed twenty degrees, the equivalent of two inches. Hence of the two variables the temperature is by far the more important.

If we select the two standards of temperature and tension here assumed, we can easily correct for temperature by simply adding to the observed height of the barometer (in tenths of an inch) the difference between 27° C. and the temperature observed. Of course the correction becomes negative if the temperature exceeds 27° C. Having thus eliminated the effect of temperature we can (after taking a few weighings under as great a variation of temperature and pressure as we can command) easily find the difference in weight which corresponds to a variation of one-tenth of an inch in the barometer, and we thus obtain a constant for the vessel (or other object weighed) by means of which we can rapidly reduce the weights to the standard of thirty inches barometric pressure, having previously reduced them to the standard of 27° C. for temperature. The weights, having now been corrected for buoyancy, can be compared, and although the standards may be as unusual in their association as is one of them in its value, they are as legitimate as any others and will be found in practice more convenient.

To apply this method we simply leave the load equi-poised on the balance, shifting the rider with the varying weight, and noting the corresponding temperatures and pressures, until a sufficient difference has been observed; and a difference corresponding to 20° C., or two inches of mercury, is adequate in most cases. The process corresponds to calibrating a flask, and the constant, once obtained, can be afterwards used for the same vessel, unless the weight of its contents is materially altered. The following examples will show the application of the method.

In each case the load was a closed absorption-tube of peculiarly irregular construction, but not much larger in volume than those generally used in organic analysis. We give in the accompanying tables—first, the date; secondly, the observed weight; thirdly, the temperature of the balance-case; and, fourthly, the height of the barometer at the time of weighing. These are the observed data. In the fifth column we give the reduced heights of the barometer for 27° C., and these values are obtained by simply subtracting the observed temperatures from 27°, and adding the remainders to the observed barometric heights. Below the tables we print in each case the largest weight observed over the least weight observed, and on the same lines the corresponding reduced barometric heights. Dividing, now, the difference of weight in milligrams, by the difference of height in tenths of an inch we obtain the value last given, which we then called the "constant." With this constant we can readily reduce all the weights to the common standard of thirty inches, and this we do by multiplying the difference between 300 and the reduced barometric heights by this constant, and adding or subtracting the product, as the case may be, to or from the observed weights (see Table, next column).

The balance here used is only sensitive under such a load to the tenth of a milligram, and hence the constancy of the results obtained is very striking. There can be no question that the mean of several weighings is accurate to the full limit of the sensibility of the instrument used. Moreover during the course of the observations it was also evident that the slight variations observed (only 3-tenths of a milligram between the extreme limits) were owing to a want of exactness in the measure of the tem-

First Series.

No.	1883.	Weight.	C.°	H.	H reduced	Result.
1	May 1	87.5304	17.	304.0	314.0	87.5346
2	May 2	87.5303	17.	304.2	314.2	87.5346
3	May 2	87.5314	19.5	303.2	310.7	87.5346
4	May 3	87.5322	20.	301.0	308.0	87.5346
5	May 4	87.53205	20.5	301.9	308.4	87.5346
6	May 4	87.5320	21.	302.5	308.5	87.5346
7	May 6	87.5316	18.	300.8	309.8	87.5345
8	May 7	87.5320	19.	300.0	308.0	87.5344
9	May 8	87.5328	19.5	298.9	306.4	87.5347
10	May 9	87.53245	22.	302.2	307.2	87.5346
11	May 11	87.5333	22.	299.5	304.5	87.5346
12	May 11	87.5333	19.5	296.2	303.7	87.5344
13	May 19	87.5317	21.	303.5	309.5	87.5346
14	May 21	87.5345	23.	296.2	300.2	87.5346
15	May 22	87.5336	22.	298.0	303.0	87.5345
		Greatest weight	87.5345	Barometer	300.2	
		Smallest weight	87.5303	"	314.2	
		Differences,	42			14.0
		Constant =	4.2 m.g. ÷ 14.0 = 0.3 m.g.			

perature of the balance-case. We used a common thermometer reading only to whole centigrade degrees; although, as afterward appeared, a difference of only 3-tenths of a degree caused a difference of 1-tenth of a milligram in the weight, and a difference of a whole degree corresponded to the extreme difference between the observations. In the second series (made with the same tube but differently mounted) we used a standard thermometer (Geisler's make) reading to tenths of a degree, and the results are all that could be expected with the instruments employed. The observations were made, nevertheless, under the most unfavourable conditions, during exceedingly hot weather when the temperature was rapidly changing; and it was evident that the insignificant differences remaining arose from the circumstance that the thermometer was not nearly so sensitive as the air in the balance-case, following the change of temperature of the air after a considerable interval of time. It was curious to notice the slight increase of weight caused by the radiation of the body while weighing, followed only after some time by a rise of the very sensitive thermometer employed, and this effect was obtained in weighing a vessel which displaced only about 75 cubic centimetres of air.

Second Series.

No.	1883.	Weight.	C.°	H.	H reduced.	Result.
1	May 29	87.3447	23.5	297.6	301.1	87.3451
2	May 30	87.3432	23.2	302.0	305.8	87.3451
3	May 30	87.3437	24.5	301.8	304.3	87.3451
4	May 31	87.3444	23.8	298.8	302.0	87.3450
5	June 1	87.3429	22.8	302.4	306.6	87.3450
6	June 1	87.3432	23.75	302.4	305.65	87.3450
7	June 2	87.3419	22.6	305.2	309.6	87.3451
8	June 3	87.3420	21.95	304.5	309.55	87.3450
9	June 3	87.3427	23.15	303.8	307.6	87.3451
10	June 4	87.3441	25.0	301.2	303.1	87.3451
11	June 5	87.3443	26.0	301.4	302.4	87.3451
12	June 5	87.3446	26.3	300.6	301.3	87.3450
13	June 6	87.34435	25.55	300.75	302.2	87.3451
14	June 7	87.3452	26.7	299.0	299.3	87.3450
15	June 8	87.3464	29.4	297.9	295.5	87.3450
		Greatest weight	87.3464	Barometer,	295.5	
		Smallest weight	87.3419	"	309.6	
		Differences,	45			14.1
		Constant =	4.5 m.g. ÷ 14.1 = 0.319 m.g.*			

* In combining only the extreme weights we must obviously take care that neither of them is seriously affected by any accidental errors; and a more certain value of the constant would be obtained by combining all the observations, after well known methods. This complication, however, is seldom necessary, as such errors would render the final results irregular, and lead to a re-discussion of the observations.

The limits in the accuracy of the method here described are obvious; but it will be noticed that the accuracy of the method is exactly proportional to the requirement. The greater the volume of the load, and hence the greater the effect of buoyancy, the more accurately can the "constant" be found, by which the correction, required in any case, may be calculated; and, as the above examples abundantly prove, the accuracy is sufficient for the purpose in view. When the volume of the load is large it becomes necessary to measure the temperature and pressure with great precision, and to protect the balance from radiation and from all causes of rapid change of temperature. It was a great satisfaction to the writer to find that by so simple means the relative weight of glass vessels of considerable size may be determined with accuracy to the tenth of a milligram, an accuracy which is fully equal to that of the most refined processes of chemical analysis, and which enables us to attain a great degree of precision in many processes which otherwise would not be susceptible of such refinement.

From the data given, and from the known normal density of the atmosphere, it can be easily calculated that in the first series of weighings the volume of the tube and mountings exceeded that of the weights by about 75 cubic centimetres. With this difference of volume we have a variation of 3 tenths of a milligram in weight for a difference of 1-10th of an inch of mercury in tension, or one centigrade degree in temperature. Hence with a difference in volume of one hundred cubic centimetres we should have a variation of weight amounting to about four milligrams for every difference of one inch in the barometer, or of ten degrees in the centigrade thermometer; and these data will furnish the basis for a rude estimate of the effect in any given case. If the difference of volume amounts to 2500 cubic centimetres, then a difference of 1-1000th of an inch in the barometer, or of 1-100th of a degree in the thermometer, would cause a variation of 1-10th of a milligram in the weight. So also a variation in the intensity of gravity amounting to only 1-30,000th of the whole amount would produce a similar effect, and a sensible variation would follow any marked change in the purity of the air. Hence the balance might be used to detect exceedingly minute changes in any one of these variables, provided the others could be exactly controlled; and, although with our better methods, these applications of the balance may be of no practical value; yet, the considerations here adduced will serve to show how sensitive the instrument is to the slightest changes in the density of the atmosphere when loaded with vessels of large volume. The best method of controlling the weight in such cases is that adopted by Regnault in his classical work on the density of the more permanent gases. This consists in balancing the vessel whose contents are to be weighed with a second vessel of equal volume, the two hanging side by side in a case lined with thick felt. The balance is set over the case and the vessels suspended from the pans by means of platinum wires, which hang freely through holes in the base of the instrument.—*American Journal of Science.*

ESTIMATION OF CHLORINE, SULPHURIC ACID, AND CHROMIUM IN THE PRESENCE OF ORGANIC MATTER.*

By CHARLES T. POMEROY.

THE determination of chlorine, sulphuric acid, and chromium in the presence of organic matter, as in the case of the analysis of many dye-stuffs, is a matter of considerable difficulty. It is necessary to get rid of the organic matter by ignition with alkali carbonate and

nitrate, else the determination of the chromium will not be reliable. During the oxidation of the organic matter a portion of the nitrate is reduced to nitrite, and on acidifying the solution, preparatory to the precipitation of the chlorine, the nitrous acid reduces some of the chromate to green chromous chloride, in the presence of which silver nitrate fails to precipitate the whole of the chlorine.* If an attempt is made to precipitate the sulphuric acid in this solution, it will be found that the barium sulphate retains chromic oxide.†

It becomes necessary, therefore, after destruction of the organic matter, to entirely convert the chromium into a chromic salt before the chlorine and sulphuric acid can be determined with accuracy. The reduction with alcohol is not practical in this case, since chlorhydric acid must be added. Neither can the reduction by means of hydrogen sulphide be taken advantage of; for, on standing in a warm place there is danger, not only of losing chlorhydric acid, but also of oxidising a portion of the hydrogen sulphide to sulphuric acid. The reduction with sulphurous acid is out of the question, for similar reasons.

The following method I have found to give satisfaction. To the solution of chromate containing sulphates, chlorides, chromates, and salts of chromium, obtained by extraction of the mass which has been fused with alkali carbonate and nitrate, and filtration from the residue, which contains the iron, lime and magnesia, a solution of potassium, sodium, or ammonium nitrate is added and then nitric acid in excess. After standing in the cold for about twelve hours, ammonium hydroxide is added and the whole boiled, the precipitate of chromic hydroxide filtered off, washed with hot water (best with the aid of a filter-pump) and estimated as usual. In the filtrate from the chromic hydroxide, the sulphuric acid is estimated as barium sulphate, by precipitation with barium nitrate and nitric acid. It is occasionally necessary to purify the barium sulphate by fusion with sodium carbonate and reprecipitation.

In the filtrate from the barium sulphate the chlorine is precipitated by silver nitrate as usual.

In the presence of an alkali nitrite and nitric acid, the reduction of the chromic acid takes place immediately on boiling the solution. Advantage may be taken of this when it is required to determine the sulphuric acid alone, since in this case there is no danger of loss on boiling.

The chromates are reduced to chromic salts by the nitrite, which passes into nitrate, while the chromous salts are oxidised by the nitric acid into the chromic state.

The following analyses were made to test the accuracy of the method:—

10 c.c. of a dilute chlorhydric acid gave—

	I.	II.	Mean.	
AgCl ..	1.0794	1.0790	1.0792	
Dissolved 2.4 grms. of $K_2Cr_2O_7$ in 200 c.c. water:—				
	I.	II.	III.†	Mean.
25 c.c. $K_2Cr_2O_7$ sol.—				
0.3000 grm.	0.3000 grm.	0.3000 grm.	0.3000 grm.	—
5 c.c. HCl	5 c.c. HCl	5 c.c. HCl	5 c.c. HCl	—
Cr_2O_3 found—				
0.1561	0.1559	0.1550	0.15566	0.15543
AgCl found—				
0.5397	0.5399	0.5391	0.53956	0.5396

In these analyses the acid was neutralised with ammonium hydroxide, sodium nitrite and then nitric acid added. It was not thought necessary to check the sulphuric acid determinations, as there was nothing in the method to interfere with this determination. In practice, the duplicate results agreed excellently.

In the analysis of commercial chrome-yellow by this

* This research was begun in the Rutgers College Laboratory and finished in Mr. Pomeroy's private laboratory in Newark.—P. T. Austen.

* Peligot, "Fres. Quant. Anal.," Last Am. Ed., 432.

† "Fres. Quant. Anal.," 1876, 354.

† Nos. 1 and 2 were precipitated in glass, No. 3 in porcelain.

method, the lead, even when present as sulphate and chloride, passes entirely into solution upon adding sodium nitrite and nitric acid in sufficient quantities and boiling.

Sodium nitrite suitable for this purpose can be prepared by simply heating to redness for some time in a closed iron vessel, sodium nitrate, free from sulphates, chlorides, and silica, until nearly one molecule of oxygen has been driven off, and then dissolving the mass in water and filtering off the oxide of iron and other insoluble impurities.

The crude sodium nitrate can be purified by dissolving the commercial article in water, filtering, precipitating sulphuric acid, if it contains any, with barium nitrate, filtering, precipitating the barium with sodium carbonate, filtering, adding an excess of nitric acid, and heating with small additions of nitric acid, until free from chlorine, nearly neutralising with sodium carbonate and then crystallising.

The method of preparing sodium nitrite mentioned by Fresenius* has not proved satisfactory in my hands as the one just given. In almost all cases the bottom of the iron vessel melts out. In one case, the iron bottom, which was a quarter of an inch thick, melted out within fifteen minutes at a hardly visible red heat. The product thus obtained is also very liable to contain but little nitrite, being almost all transformed into the hydroxide, and hence has but little reducing effect on the chromates. It is perhaps possible that the oxide of lead acts as a carrier of oxygen to the iron, taking up oxygen from the nitrate and giving it up to the iron. In this way a small quantity of lead oxide might effect the destruction of a large amount of iron.—*American Chemical Journal*.

A RECALCULATION OF THE ATOMIC WEIGHTS.†

By FRANK WIGGLESWORTH CLARKE, S.B.,
Professor of Chemistry and Physics in the University of Cincinnati.

SILVER, POTASSIUM, SODIUM, CHLORINE, BROMINE, IODINE, AND SULPHUR.

Continued from p. 34).

THE ratio between silver and potassium iodide seems to have been determined only by Marignac,‡ and without remarkable accuracy. In five experiments 100 parts of silver were found equivalent to potassium iodide as follows:—

1.616 grm. Ag = 2.483 Ki	Ratio, 153.651
2.503 " 3.846 "	" 153.665
3.427 " 5.268 "	" 152.720
2.141 " 3.290 "	" 153.667
10.821 " 16.642 "	" 153.794
Mean, 153.6994 ± 0.0178	

The synthesis of silver iodide has been effected by both Marignac and Stas. Marignac, in the paper above cited, gives these weighings. In the last column I add the ratio between iodine and 100 parts of silver:—

15.000 grm. Ag gave 32.625 AgI.	117.500
14.790 " 32.170 "	117.512
18.545 " 40.339 "	117.519

Mean, corrected for weighing in air, 117.5335 ± 0.0036

Stas|| in his experiments worked after two methods,

* "Qual. Anal.," Last Am. Ed., 71.
† Smithsonian Miscellaneous Collections. "The Constants of Nature."
‡ "Berzelius's Lehrbuch," 5th edition, vol. iii., pp. 1196.
|| "Aronstein's Translation," pp. 136, 152.

which gave, however, results concordant with each other and with those of Marignac.

In the first series of experiments Stas converted a known weight of silver into nitrate, and then precipitated with pure hydriodic acid. The iodide thus thrown down was washed, dried, and weighed without transfer. By this method 100 parts of silver were found to require of iodine:—

117.529
117.536

Mean, 117.5325, ± 0.0024

In the second series a complete synthesis of silver iodide from known weights of iodine and metal was performed. The iodine was dissolved in a solution of ammonium sulphite, and thus converted into ammonium iodide. The silver was transformed into sulphate and the two solutions mixed. When the precipitate of silver iodide was completely deposited the supernatant liquid was titrated for the trifling excess of iodine which it always contains. As the two elements were weighed out in the ratio of 127 to 108, while the atomic weight of iodine is probably a little under 127, this excess is easily explained. From these experiments two sets of values were deduced; one from the weights of silver and iodine actually employed, the other from the quantity of iodide of silver collected. From the first set we have of iodine for 100 parts of silver:—

117.5390
117.5380
117.5318
117.5430
117.5420
117.5300

Mean, 117.5373 ± 0.0015

From the weight of silver iodide actually collected we get as follows. For experiment number three in the above column there is no equivalent here:—

117.529
117.531
117.539
117.538
117.530

Mean, 117.5334 ± 0.0014

Now, combining these several sets of results, we have the following general mean:—

Marignac	117.5335 ± 0.0036
Stas, 1st series ..	117.5325 0.0024
" 2nd " ..	117.5373 0.0015
" 3rd " ..	117.5334 0.0014
General mean ..	117.5345 ± 0.0009

One other comparatively unimportant iodine ratio remains for us to notice. Silver iodide, heated in a stream of chlorine, becomes converted into chloride; and the ratio between these two salts has been thus determined by Berzelius and by Dumas.

From Berzelius* we have the following data:—In the third column I give the ratio between AgI and 100 parts of AgCl.

5.000 grm. AgI gave 3.062 AgCl	163.292
12.212 " 7.4755 "	163.360

Mean, 163.326 ± 0.023

Dumas'* results were as follows:—

3.520 grm. AgI gave 2.149 AgCl.	163.793
7.011 " 4.281 "	163.770

Mean, 163.782 \pm 0.008

General mean from the combination of both series, 163.733 \pm 0.0076.

We now come to the ratios connecting sulphur with silver and chlorine. Other ratios have been applied to the determination of the atomic weight of sulphur, but they are hardly applicable here. The earlier results of Berzelius were wholly inaccurate, and his later experiments upon the synthesis of lead sulphate will be used in discussing the atomic weight of lead. Erdmann and Marchand determined the amount of calcium sulphate which could be formed from a known weight of pure Iceland spar; and later they made analyses of cinnabar, in order to fix the value of sulphur by reference to calcium and to mercury. Their results will be applied in this discussion towards ascertaining the atomic weights of the metals just named. For our present purposes only three ratios need be considered.

First in order let us take up the composition of silver sulphide, as directly determined by Dumas, Stas, and Cooke. Dumas† experiments were made with sulphur which had been thrice distilled and twice crystallised from carbon disulphide. A known weight of silver was heated in a tube in the vapour of the sulphur, the excess of the latter was distilled away in a current of carbon dioxide, and the resulting silver sulphide was weighed.

I subjoin Dumas' weighings, and also the quantity of Ag₂S proportional to 100 parts of Ag, as deduced from them:—

9.9393 grm. Ag = 1.473 S	Ratio, 114.820
9.962 " 1.4755 "	" 114.811
30.637 " 4.546 "	" 114.838
30.936 " 4.586 "	" 114.824
30.720 " 4.554 "	" 114.824

Mean, 114.8234 \pm 0.0029

Dumas used from ten to thirty grms. of silver in each experiment. Stas,‡ however, in his work, employed from sixty to two hundred and fifty grms. at a time. Three of Stas' determinations were made by Dumas' method, while in the other two the sulphur was replaced by pure sulphuretted hydrogen. In all cases the excess of sulphur was expelled by carbon dioxide, purified with scrupulous care. Impurities in the dioxide may cause serious error. The five results come out as follows for 100 parts of silver:—

114.854
114.853
114.854
114.851
114.849

Mean 114.8522 \pm 0.0007

The experiments made by Professor Cooke|| with reference to this ratio were only incidental to his elaborate researches upon the atomic weight of antimony. They are interesting, however, for two reasons: they serve to illustrate the volatility of silver, and they represent, not syntheses, but reductions of the sulphide by hydrogen. Cooke gives three series of results. In the first the silver sulphide was long heated to full redness in a current of hydrogen. Highly concordant and at the same time plainly erroneous figures were obtained; the error being eventually traced to the fact that some of the reduced silver, although not heated to its melting-point, was

actually volatilised and lost. The second series, from reductions at low redness, are decidedly better. In the third series the sulphide was fully reduced below a visible red heat. Rejecting the first series we have from Cooke's figures in the other two the subjoined quantities of sulphide corresponding to 100 parts of silver:—

7.5411 grms. Ag ₂ S lost 0.9773 S.	Ratio, 114.889
5.0364 " 0.6524 "	" 114.882
2.5815 " 0.3345 "	" 114.886
2.6130 " 0.3387 "	" 114.892
2.5724 " 0.3334 "	" 114.891

Mean 114.888 \pm 0.0012

1.1357 grm. Ag ₂ S lost 0.1465 S.	Ratio, 114.810
1.2936 " 0.1670 "	" 114.823

Mean 114.8165 \pm 0.0044

Now, combining all four series, we get the following results:—

Dumas	114.8234 \pm 0.0029
Stas	114.8522 0.0007
Cooke's 2nd	114.888 0.0012
" 3rd	114.8165 0.0044

General mean .. 114.8581 \pm 0.0006

Here again we encounter a curious and instructive compensation of errors, and another evidence of the accuracy of Stas.

(To be continued.)

THE CITY CHEMICAL TRADES.

A MEETING of gentlemen interested in the chemical trades of London was held on July 23 at the offices of the London Chamber of Commerce, 84 and 85, King William Street, E.C. There were present Messrs. T. Farmer Hall, W. Caudery, W. Tennant, J. G. Johnson, John T. C. Winkfield, W. G. Blagden, John Blott, D. W. Greenhough, Thomas Tyrer (May and Baker), A. C. Wootton, Bernard Dyer, H. R. Smith and J. Denham Smith (Teschemacher and Smith), G. Bennett, L. A. Bennett, Herbert G. Bennett, David Howard, J. Hartford (Burgoyne, Burbidge, and Co.), Geo. Wigner (Wigner and Harland), G. H. Ogston, V. H. Cannon, and Kenric B. Murray, Secretary.

The meeting decided that the chemical trades should be divided into four sections:—The first, composed of analytical chemists and scientific societies; the second, of chemical manufacturers; the third, of chemical merchants, brokers, &c.; and the fourth, of drysalts and druggists. The names of thirty firms were then submitted to form a committee. The following were elected, it being understood that most of the nominees accepted:—Messrs. G. H. Ogston; J. Hughes; Wigner and Harland; Teschemacher and Smith; Bernard Dyer; F. Manning; May and Baker; Howards and Sons; Pontifex and Wood; Thomas Farmer and Co.; James Gibbs and Co.; Odam's Manure Company; Lawes' Chemical Manure Company; Johnson, Matthey, and Co.; Johnson and Sons; Spence, Chapman, and Co.; John Blott; Hopkin and Williams; Astley P. Price; C. Tennant, Sons, and Co.; Pokorny, Fielder, and Co.; Geo. Bennett and Son; G. M. Bauer; D. W. Greenhough; Blagden and Angus; W. Caudery and Co.; G. J. Saunders; Geo. Atkinson and Co. The list of drysalts was not completed, nominations for this section being left to a future date.

The Committee then nominated Mr. David Howard Chairman of the Section, and Mr. John Blott, Vice-Chairman; and it was decided to hold a general meeting of the whole of the chemical trade of London, both of

* *Ann. Chem. Pharm.*, 113, 28. 1860.

† *Ibid.*, 113, 24. 1860.

‡ "Aronstein's Translation," p. 179.

|| *Proc. Amer. Acad. Arts and Sciences*, vol. xii., 1877

those who were not members of the Chamber but would be willing to qualify as such, and of those who were already members, on Monday, July 30, at 2 o'clock.

NOTICES OF BOOKS.

Agricultural Chemical Analysis. By PERCY FRANKLAND, Ph.D., B.Sc., F.C.S. Founded upon "Leitfaden für die Agrikultur Chemische Analyse," von Dr. F. KROCKER. London: Macmillan and Co.

MANUALS of chemical analysis as specially applied to agriculture have not, like elementary treatises on general chemistry, multiplied to the utter despair of reviewers; nevertheless the author of the work before us does not enter upon an untrodden field. It comes into competition especially with Prof. Church's well-known "Laboratory Guide," which covers almost identically the same ground.

The responsibility of this book appears to be divided. The author, as he tells us in his preface, set out with the intention of giving merely a translation of Dr. F. Krockers work. He then judged it desirable to omit almost entirely those parts of the latter which treat of the general principles of chemical analysis as to extend the more strictly agricultural portion. He has further availed himself of the "French Handbook of Agricultural Chemical Analysis" by Prof. Grandeau, which, however, to judge from a footnote on p. 196, he appears to have consulted in a German translation.

The first point that strikes us on an examination of this book is the somewhat needless liberality in the use of formulæ. Surely in a book on chemical analysis, and especially in one where the reader is "assumed to be already conversant with general principles," formulæ are called for only where they may serve as a kind of shorthand, where they may identify some compound more precisely than could be done in words, or where they show in brief the percentage of some constituent. But here we find occasionally structural formulæ which badly answer this latter purpose, even sometimes superadded to empirical formulæ. For instances of the space thus taken up we may refer to pp. 8, 28, 30, 39, 67, 185, 188, &c. Whatever value such formulæ may possess they seem here out of place.

Turning to the subject-matter of the work it would be more than singular if the methods of procedure and other instructions here laid down were not fully on a level with the knowledge of the present day. A few points, however, may require discussion. On p. 201 we find a useful classification of manures according to the ingredients of agricultural value which they contain. Here, among the "phosphoric acid and potash" manures we find mention of coal-ash. Yet on turning to p. 146 we see the potash in coal-ash given as 0.22 per cent., and the phosphoric acid has a "trace," whilst on p. 145 it is stated that "the ashes of coal are of value as manure on account of the sulphuric acid and soluble silica which they contain."

In the instructions for alkalimetry and acidimetry we find no mention of dimethylamylne-orange, or the alcoholic solution of amido-azobenzene as indicators. Cochineal figures here as "cochenille," which is certainly not the English way of writing the name of this dye-ware.

The section on the estimation of ingredients prejudicial to the fertility of a soil is of great value, the more as the search for and determination of such agents is often overlooked. The author enumerates here common salt in quantities exceeding 0.1 per cent, ferrous oxide and sulphur when existing as metallic sulphides or in organic combinations. Other sterilizers will doubtless be recognised where industrial refuse and the sewage of manufacturing towns finds its way upon the land.

In speaking of the methods of incinerating organic matter, Mr. Frankland recommends the addition in certain cases of baric hydrate. This method is undeniably useful,

but we would submit that barium peroxide is still more efficient.

On the analysis of milk the author gives a somewhat uncertain sound, declaring that it is not always possible to ascertain by analysis whether the poverty of milk is due to artificial or "natural causes." Here he certainly disagrees with some chemists who have given this subject their especial attention, and he overlooks, apparently, the fact that milk, as offered for sale in our large towns, is not the product of a single animal but of a herd, and may consequently be expected to form a general average. He states, indeed, on the authority of Grandeau, that the water in milk may vary between 80 and 88.65 per cent, the nitrogenous solids (caseine and albumen) from 3.30 to 5.55, and the milk sugar from 3 to 5.50. But he does not say whether Grandeau finds that a low percentage of caseine is accompanied by a correspondingly low proportion of milk-sugar, or that, on the contrary, a compensation takes place, the rise of one of these constituents implying a fall of the other. In other words he gives no opinion as to the constancy of the "solids not fat"—a feature which, indeed, he entirely ignores. He gives no indications for the detection of borax and salicylic acid, bodies understood to be occasionally added to milk not as true adulterants, but to prevent it from turning sour. We are glad to find that Mr. Frankland gives no countenance to the lactometer the creamometer, and such pseudo-scientific playthings.

We next turn to butter. Here the author quotes a table to show the typical composition of the butters of different countries. We are rather surprised to see that in the two English samples fat, caseine, and water make up the full 100 per cent without any salt being present. This is remarkable, since in good fresh butter, the salt is really below 1 per cent, whilst in some samples it reaches 10 per cent. It is distinctly stated here that inferior butters are now largely adulterated with lard, tallow, oleomargarine, &c. But no method is given for their detection. We can only conclude that Mr. Frankland regards the various processes devised for this purpose, based upon the specific gravities, the solubilities, volatilities, melting-points, &c. of the fats as utterly untrustworthy. His scheme for the examination of butter extends only to water, fat (as a totality), caseine and ash, sugar, and salt. Sugar, we may mention, is not noted as occurring in any of the samples analysed by Grandeau.

The analysis of water occupies sixty pages, or very nearly one-fifth of the entire book,—an extent which the author admits is greater than "might at first appear warrantable." He seeks, however, to justify the prominence given to this subject as follows—"The services which water-analysis can render to agriculture are of the greatest importance, for by frequent analysis of the drainage water flowing from his fields the farmer is enabled to ascertain whether or not his soil is being impoverished by the method of drainage he has employed, whilst by the analysis of liquid manures he is able to estimate the agricultural value of any system of irrigation."

To these arguments it may be replied that the agricultural value of any system of irrigation depends mainly on the climate. The greater or more uniform the rainfall and the less the evaporation the more concentrated and the less soluble the manures applied must evidently be, if their valuable constituents are not to disappear in the drainage. Hence in so cold and moist a country as England, where water, for most crops and in most seasons is the *summum malum*, systems of irrigation are best left alone.

The preliminary instructions for the collection of samples are full and useful, though differing merely in language from the directions given by Mr. Wanklyn in his treatise on water-analysis. In determining total dissolved matter Mr. Frankland uses from $\frac{1}{4}$ to $\frac{1}{2}$ l. tre. We are glad to find that he does not overlook the possible presence of phosphoric acid, an impurity—from the sanitary point of view—which has been neglected by many authorities, but which, according to our own experience, is by no means

uncommon, and which in wells and drinking-waters generally is of grave significance.

The determination of ammonia is directed to be performed by the Nessler process, but no mention is made of Mr. Hadow and Dr. Miller, who first rendered this test quantitative.

For the estimation of nitrites, Mr. Frankland recommends one of the methods of Griess, that based upon the reaction of metaphenylene diamine with nitrous acid, when a yellow colour is produced.

The determination of nitric acid or nitrates is described at great length, the preference being evidently given to the indigo-process as modified by Mr. Warington. The determination of the albumenoid ammonia or organic nitrogen by the process of Wanklyn, Chapman, and Smith, is completely ignored. The estimation of total organic matter as loss on ignition is—in our opinion very wisely—omitted. Overlooking all other considerations the mere fact that certain organic compounds may be volatilised or seriously modified before all water of hydration is driven off, deprives this process of all scientific value.

In his account of the determination of organic matter by the permanganate process, or as he calls it the Forchammer or oxygen process, the author makes no mention of the improvement of Kübel, who applies the solution at a boiling heat and thus obtains, at a less outlay of time, a more complete oxidation. In the cold we have found living organisms retain their vitality for hours in the presence of a large excess of potassium permanganate. The determination of the free oxygen in water by the hydrosulphite process is not mentioned. For the determination of lead and copper in water the author recommends the colorimetric process as originally devised by W. A. Miller, and as described by Mr. Wanklyn. Instead of ammonium sulphide he uses a saturated solution of sulphuretted hydrogen. Arsenic he detects by the Marsh process, but chromium, which is a very probable ingredient in the sewage of manufacturing towns, he overlooks. For the detection of barium he recommends a solution of calcium sulphate, a decidedly safer reagent than sulphuric acid. Attention may here be called to the use of strontium in the arts, since, though not poisonous, it might, on a superficial examination, be mistaken for barium.

The determination of organic carbon and organic nitrogen in water by the combustion-process is finally given. As an appendix follow tables of symbols and atomic weights, of the percentages of pure sulphuric, hydrochloric, and nitric acids in the aqueous acids of different specific gravities, and also of caustic potash, soda, and actual ammonia in aqueous solutions.

For several substances, such as soot, commercial sulphate of ammonia, certain compound manures, *e. g.* phospho-guano, and compound cattle-loods and condiments, no special instructions are given. On the other hand, the complete analysis of tobacco is given in full detail.

With some insignificant exceptions this work may be pronounced a safe and useful guide for the student of agricultural chemistry. In the next edition we should recommend the introduction of an index.

CORRESPONDENCE.

CHEAP ANALYSES.

To the Editor of the Chemical News.

SIR,—Some time ago I received from the Clerk of a suburban Local Board, a letter requesting me to let him know my fees for water analyses. A tabular statement of my charges for examinations, ranging from such a qualitative investigation as might serve to afford a preliminary notion regarding the purity of a water to the more elaborate ex-

amination which is necessary when the fitness of a water for dietetic uses is seriously questioned, was sent to him; and after about ten days a letter arrived suggesting that I should, "under the circumstances," perform the analyses for 10s. 6d. each. A further perusal of the letter revealed that the "circumstances" were as follows:—A gentleman, whose name was previously unknown to me, but who puts F.C.S. and F.I.C. after his name, had been in the habit of doing the following work for 10s. 6d. per sample; and orders for the closing of certain wells in the parish had been obtained on the strength of his analyses:—

Work done for 10s. 6d.

- Estimation of total solids.
- Estimation of free ammonia.
- Estimation of albumenoid ammonia.
- Estimation of chlorine.
- Estimation of total hardness.
- Estimation of permanent hardness.
- (Temporary hardness by difference.)
- Qualitative examination for lead, &c.
- Written opinion or report as to fitness of water for domestic use.

Although the work of testing for lead alone, including the necessary precautions for guarding against the accidental introduction of traces of metals of the first group, would, in the hands of a careful chemist, take considerably over twelve hours: let us assume that the whole of the work could be performed with *moderate care* in eleven or twelve hours. This would provide for remuneration to the analyst at the rate of something less than one shilling per hour, or about the same as earned by a bricklayer; while, if we assume that the analysis is performed with anything like the care and attention to detail which is considered necessary during original research, the sum realised by the cheap analyst would dwindle down to three or four pence per hour.

Many circumstances have tended of late to inaugurate a system of cheap and hastily performed analysis, the rates charged varying from one-eighth to one-twentieth of the fees which would be paid to a chemist of position; and the whole subject of cheap analysis—their almost universal failure when further investigation is made—the astonishing deductions drawn from them—and their forensic bearing, might well be discussed with detail in the columns of the CHEMICAL NEWS.—I am, &c.,

THOMAS BOLAS.

July 21, 1883.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvi., No. 2, July 9, 1883.

Pyro-electricity in Blende, Sodium Chlorate, and Boracite.—C. Friedel and J. Curie.—The authors conclude that in hexagonal substances having three horizontal axes of hemi-morphism, and in cubic substances belonging to the type of tetra-hedric hemihedrism, when there is regular cooling or heating of the crystal, *i. e.*, when the expansions are equal in respect to the different axes in question, there is compensation from a pyro-electric point of view, and no disengagement of electricity is observed. It is obtained, on the contrary, when an irregular variation of temperature, or a compression affecting certain axes more than others produces unequal expansion.

Separations of Gallium.—Lecoq de Boisbaudran.—Will be inserted in full.

Ultra-red Emission Spectra of Metallic Vapours.—Henri Becquerel.—The method of observation which the author describes opens up a new field in spectral analysis, comprising, between the wave-lengths 760 and 1300, an interval of wave-lengths greater than that existing between the extreme red of the visible spectrum and the last of the known violet rays.

Novel Method for Determining the Limits of Electrolysis.—Ch. Truchot.—The author founds his method upon M. Berthelot's law that "the decomposition of electrolytes is effected as soon as the smallest sum of the necessary energies, foreseen according to the quantities of heat, is present. In this manner, from the limits of the electromotive forces employed, it is possible to deduce the quantities of heat necessary to effect decompositions. We have thus a means of determining or of verifying certain formation heats.

On Samarium.—P. T. Clève.—See page 39.

Blue Colouration obtained by the Action of Chromic Acid upon Hydrogen Peroxide.—H. Moissan.—The compound formed is not, as was supposed by Barreswil, perchromic acid, but a compound of chromic acid with hydrogen dioxido, CrO_3HO_2 .

Tetric Acid and its Homologues.—W. Pawlow.—The author shows that the tetric acid of Demarçay may be regarded as acetylic acrylic acid.

Dimorphism of Silver Iodide.—MM. Mallard and Le Chatelier.—The authors show that silver iodide undergoes a change of state similar to that of boracite.

New Reactions characteristic of the Salts of Gold.—Ad. Carnot.—If we pour into a small phial a few drops of a dilute solution of gold chloride, some drops of arsenic acid, two or three drops of ferric chloride, and the same quantity of hydrochloric acid, and about 100 c.c. of water, and introduce a fragment of zinc, the liquid soon takes a purple colour in the neighbourhood of the zinc, and on shaking takes throughout a fine rose or purple colour. The experiment thus conducted may last for half an hour, but it is completed in a few moments if we use some centigrammes of zinc powder and shake the phial. The rose colouration is also immediate if we pour into the solution of the salt of gold, prepared in the same manner, some drops of the liquid obtained by attacking metallic iron with dilute hydrochloric acid, or, better, by heating it with a mixture of hydrochloric acid and arsenic acid. It is diluted with water, and left in contact with an excess of metal. This reaction is extremely sensitive. If one-millionth part of gold is present the change of colour is very visible, and it may be distinguished even with a proportion of gold one-half less. The author purposes showing at an early opportunity how the same reaction may be applied in quantitative determinations. If phosphoric is used in place of arsenic acid the colouration is blue or violet. Hydrochloric acid alone gives a rose colouration, but less bright than with the addition of arsenic acid.

Sodium Alcoholates.—M. de Forcrand.—A thermochemical paper, in which the author shows that water and alcohol play a part substantially equivalent to each other in presence of soda and of sodium.

Pyrogenation of Resin.—Ad. Renard.—By the destructive distillation of resin at dull redness the author has obtained two new isomeric carbides, for which he proposes the name colophanthrene. The yellow compound is very slightly soluble in alcohol, from which it is deposited on cooling in yellow crystals with a greenish fluorescence. It boils above 360° . The white compound is much more soluble, and is deposited in white brilliant crystals with a violet fluorescence. It melts at 87° , and boils about 360° . Both carbides, if oxidised with chromic acid in acetic solution, yield a diacetone, whilst carbonic acid escapes. This diacetone, if heated with fuming sulphuric acid, gives rise to a sulpho-conjugated acid, the potassium salt of which, if heated to 170° in a sealed tube with a strong solution of caustic potassa, is transformed into a mass of

an intense violet colour. If dissolved in water and decomposed with hydrochloric acid it yields a colouring-matter, which on cotton mordanted with alumina dyes a shade similar to that given by alizarin.

Contribution to the Study of Panary Fermentation.—L. Bouteux.—The author refers to the memoirs of M. Chicandard (*Comptes Rendus*, xcvi., p. 1585) of M. Marcato (*Ibid.*, June 11), and of M. Moussette (*Ibid.*, June 25). His own researches, carried out previously to those of M. Chicandard, confirm the theory of the latter as to the principal point, but they agree so far with the phenomena cited by M. Moussette that we may pronounce this theory too exclusive.

Method for Estimating the Value of the Wines of the South.—A. Audouaud.—The author mixes 5 c.c. of the wine with 10 c.c. of a solution of baryta saturated in the cold. A precipitate is formed, which if washed immediately in boiling water, gives a liquid unstable in the air, readily oxidised, and of a yellowish colour. After having removed the excess of baryta by a current of carbonic acid, and made up the liquid with water to 100 c.c., the proportion of yellow colouring matter may be judged of on oxidising with a standard solution of potassium permanganate. The numbers thus obtained, compared with the alcoholic standard of the wine, enable an opinion to be formed on its value.

Journal de Pharmacie et de Chimie.
Tome viii., July, 1883.

Pharmacological Researches on Methylene Chloride.—J. Regnaud and E. Villejean.—This paper treats on the use of methylene chloride as an anæsthetic in surgical operations.

Analysis of the Mineral Water of Heucheloup.—J. Lefort.—This paper presents no general interest.

Action of Sulphur on the Alkaline Phosphates.—MM. E. Filhol and Senderens.—Finely divided sulphur has no appreciable effect upon solutions of potassium and sodium phosphate at common temperatures. At 100° there ensues formation of alkaline poly-sulphides and hypo-sulphites. The trisodic phosphate is converted, first into a disodic, and ultimately into a sesquisodic salt. The authors hence regard phosphoric acid as a sesquibasic acid of mixed functions.

Variations in the Composition of Semen in Pathological Cases.—C. Méhu.—A medical paper.

Cultivation of the Cacao. Researches on the Constitution of Cacao Beans and of Chocolate.—M. Boussingault.—The nature of this memoir appears sufficiently from its title.

Intestinal Sand.—M. Yvon.—Analyses of a sandy concretion voided in certain pathological cases.

Balloons of Oxygen.—E. Godin.—The author proposes to send out oxygen gas in toy balloons, to be inhaled as a remedy for asthma.

Analysis of a Salivary Calculus.—A. Mallat.—Of merely medical interest.

Cupric Solutions employed in the Detection of Glucose.—M. Sonnerat.—The author prepares his solution as follows:—Dissolve to saturation in the cold, and in distilled water, 34.639 grms. copper sulphate, pure and crystalline. In another vessel dissolve, also in the cold, in 600 grms. caustic soda-lye (of sp. gr. 1.12), 173 grms. potassium tartrate, chemically pure and crystalline. To this alkaline liquid add, little by little, the cold solution of copper sulphate, and dilute the whole to 1 litre.

The Cadmium-potassic Reagent.—M. Lepage.—The author dissolves in 50 grms. distilled water, 2.8 grms. cadmium iodide and 2.5 grms. potassium iodide, and filters the solution. A few drops of this reagent produce a marked turbidity, or even a precipitate in solution of crude

opium, extract of opium, extract of yellow cinchona, extract of nux vomica, and tincture of cinchona.

Paraffin Exsiccator.—M. Liebermann.—For substances dissolved in carbon disulphide, ether, chloroform, &c, the author uses an exsiccator in which paraffin is substituted for sulphuric acid. Paraffin absorbs its weight of carbon disulphide in four or five hours, ether in eight or nine hours, and chloroform in nine to ten hours. These liquids are then recovered by distillation.

Biedermann's Central-Blatt für Agrikultur-Chemie,
Vol. xii., Part 5.

Colour of Water.—W. Spring.—Pure water has in itself a blue colour if observed in a stratum of sufficient thickness. In natural waters which appear blue calcium and magnesium carbonate, silica, and alumina exist in solution. In green waters the same salts exist, from deficiency in carbonic acid, in imperfect solution, or in partial suspension.

Influence of Temperature and Rainfall upon the Wheat-Crop.—A. v. T.—The author shows that the wheat-crop is mainly determined by the state of the weather in July and August—the higher the temperature in those two months, and the smaller the rainfall, the better being the harvest. The author's conclusions are based upon English statistics extending over thirty-six years. The best harvest was that of 1868, with a temperature for the two months of 41° F. above the average, and a rainfall of 2.71 inches below the average, but the worst was that of 1865, with a deficiency of temperature of 4.6° F., and an excess of 2.6 inches of rain. In 1879 the deficiency of temperature was only 2.8° F., but the excess of rainfall was 4 inches.

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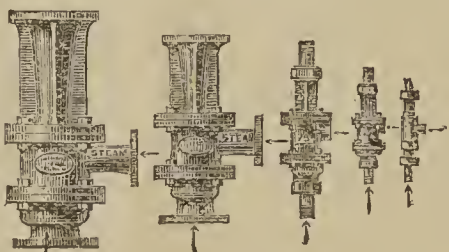
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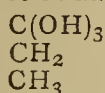
VOL. XLVIII. No. 1236.

ON THE CONSTITUTION OF THE NATURAL FATS.

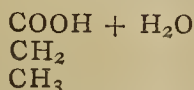
By J. ALFRED WANKLYN and WILLIAM FOX.

IN the course of an investigation in which we are at present engaged we have arrived at some results which appear to us to be very interesting. We find that the generally received view that the fats are ethers of glycerin is partially correct, and that instances of a different kind of structure occur among the natural oils and fats.

Ethers of iso-glycerin, or of homologues of iso-glycerin, appear to occur. Iso-glycerin has this structure:—



It exists in its ethers, but cannot be isolated, and should be resolved into:—



Ethers of iso-glycerin, or ethers of homologues of iso-glycerin, yield no glycerin when saponified.

July 26, 1883.

ON THE IDENTIFICATION OF MINUTE QUANTITIES OF SILVER CYANIDE.

By C. L. BLOXAM.

IF a particle of precipitated silver cyanide be examined by the microscope with a quarter-inch objective it appears as an amorphous mass, but if a drop of ammonia be placed upon it, and very gently warmed, it will form very distinct needle-like crystals. Silver chloride treated in the same way gives very minute octahedra. In a mixture of silver cyanide and silver chloride both constituents may be identified in this way. When the silver cyanide is present in very small proportion the silver chloride forms strings of minute octahedra, interspersed with the needles of silver cyanide.

In the ordinary course of qualitative analysis, where the cyanide and chloride are precipitated together by silver nitrate from a solution acidified with nitric acid, this test is found useful. Silver sulphocyanide forms needles when treated in the same way, but the absence of a sulphocyanide can be ascertained by the ferric chloride test. Silver cyanide is also deposited in minute needles when boiled with a strong solution of sodium carbonate and allowed to cool. Unless the boiling be prolonged but little of the cyanide is decomposed.

When precipitated silver cyanide is boiled with dilute nitric acid (sp. gr. 1.2) it is dissolved, and on cooling is deposited, sometimes in a semi-transparent gelatinous form, and at others in white masses, which are seen under the microscope to consist of beautiful stellate groups of needles. Similar groups may be obtained by moistening precipitated silver cyanide with strong nitric acid on a glass slide, and gently warming.

If the solution of silver cyanide in hot dilute nitric acid be cooled in a test-tube, under the water-tap, its behaviour is quite characteristic: if the test-tube be kept still the cyanide separates in the semi-transparent gelatinous form,

but, on gently shaking, this collects suddenly into opaque masses, which generally appear as groups of needles under the microscope.

When silver cyanide is precipitated together with silver chloride, it may be separated by boiling the mixed precipitate with nitric acid, filtering while hot, and cooling the solution. The deposited silver cyanide may be finally tested by heating it with yellow ammonium sulphide, evaporating the solution of ammonium sulphocyanide thus obtained, and testing with ferric chloride.

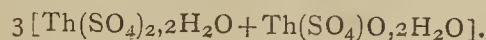
King's College, London,
July 26, 1883.

ON THORIUM SULPHATE.

By EUG. DEMARCAY.

M. NILSON has published in the *Comptes Rendus* (xcv., pp. 727, 729, and 783, and xcvi., p. 346), a series of memoirs on the thorite of Arendal and on thorium sulphate. The author, having been engaged for some time upon the same subject, has arrived at similar conclusions as regards the composition of thorite and almost the same concerning the purification of thorium. It is, however, possible to obtain an almost perfect separation of thorium and the metals of cerite and gadolinite by the alternate application of the methods of fractionated crystallisation, and of dissolving thorium oxalate in ammonium oxalate (*Vogel, Praktische Spectral Analyse*, p. 152). But the study of thorium sulphate has led to different results. M. Nilson admits that thorium sulphate possesses a solubility which decreases with a rising temperature, basing this conclusion probably on the ready solubility of the anhydrous sulphate in cold water, and the almost complete precipitation of the thorium at the boiling-point. But as the anhydrous sulphate is converted into hydrates in presence of water, so that these only can come in question, and accordingly as we consider the one or the other hydrate, the solubility may be very different at one and the same temperature; finally, at 100° pure water decomposes thorium sulphate.

A dilute and neutral solution of thorium sulphate ($\frac{1}{2}$ per 1000) if submitted to the action of heat becomes gradually turbid, and at 100° there is formed a flocculent basic salt, as may be easily found on its isolation; 0.1 grm. of sulphuric acid per litre of water prevents its formation. This dissociation by water, barely perceptible in the cold, is very manifest in heat. The author has not completed the analysis of this salt. Hot water acts differently upon concentrated solutions. The hydrate containing 9 mols. of water if mixed with ten or fifteen times its weight of water is converted at 60° into a mass of a cotton-like appearance which a temperature of 100°, if kept up for 24—48 hours, transforms into a pulverulent precipitate, which is no longer soluble in the cold. The salt thus formed is basic, and answers to the formula—



The quantity of sulphate remaining in solution is minute, scarcely 0.1 to 0.2 per cent under the above conditions and varying with the quantity of water present. A notable quantity of free acid (3 to 4 per cent) greatly hinders the formation of this basic salt. In presence of little water little of the salt is produced. Basic thorium sulphate is scarcely attacked by cold water, and even the acids act but slowly.

The solubility of the various hydrated sulphates is very different; their solutions are easily supersaturated, which renders their study the more tedious. The solubility of the hydrate with 9 mols. of water increases regularly with the temperature; 100 grs. of the solution at 0° contain 1.2 grm. of the hydrated salt, but at 54° 8 to 9 grms. Above 55° thorium sulphate possesses a very considerable solubility, but a saturated solution cannot be formed without turbidity, owing to a deposit of the cotton-like hydrate, which takes place rapidly at 60°.

The other hydrates of thorium sulphate are much less known. The author has studied the hydrate with 4 mols. of water which had been previously obtained by Chydenius and which is probably identical with Delafontaine's hydrate with $4\frac{1}{2}$ mols. of water. He obtains this hydrate pure and constant in composition by keeping the hydrate with 9 mols. at 100° in presence of water containing 5 per cent of sulphuric acid. As regards the solubility of this hydrate 100 grms. of the solution contain at 17° 8.6 grms. of the anhydrous sulphate, but at 100° only 0.3 gm. Below 17° it is impossible to saturate the solution without the hydrate containing 9 mols. of water being deposited. —*Comptes Rendus*.

SEPARATIONS OF GALLIUM.

By M. LECOQ DE BOISBAUDRAN.

Separation from Tellurium.—The liquid containing tellurium in the state of tellurous acid is mixed in the cold with a sufficiency of hydrochloric acid and saturated in the cold with sulphuretted hydrogen. Tellurium sulphide is precipitated, whilst the gallium is found in the filtrate, which is not, however, always absolutely free from tellurium. In an accurate analysis the clear liquid should therefore be boiled for some minutes, whilst a current of hydrogen sulphide is passed through it, and the slight traces of tellurium sulphide obtained by this second operation are collected on a filter. When the volume of the filtrate is considerable, it is preferable to begin by concentrating to a small bulk before treating with sulphuretted hydrogen in heat.

Separation from Silica.—If free sulphuric acid exists in the liquid it is strongly acidified with hydrochloric acid and evaporated to dryness, at first at 100° ; then, when all visible traces of liquid have disappeared the residue is kept for fifteen to twenty minutes at 120° – 125° .

When cold the mass is moistened with dilute hydrochloric acid and evaporated to dryness a second time in the same manner.

The mixture of silica and the salts of gallium is sprinkled with a little hydrochloric acid, and then heated to 100° for some minutes, in order to dissolve entirely the gallium oxychlorides, which have been formed during desiccation. Care must be taken that no part of the matter is now dried up. Water is then added and the liquid is heated to near the boiling-point whilst being stirred.

The silica is then collected upon a filter and washed for a long time, at first with water acidulated with hydrochloric acid, and then with pure water. The gallium is easily extracted from the filtrate by expelling the greater part of hydrochloric acid by evaporation and precipitating with cupric hydrate.

Whatever care has been taken in washing the silica it retains almost always slight traces of gallium. In an exact analysis, especially if the quantity of silica is large, it must be re-dissolved in potassa, supersaturated with hydrochloric acid, and treated again as above. —*Comptes Rendus*.

The Digestion of Cows' Milk, and the Means of Increasing its Digestibility.—Prof. J. Uffelmann.—The precipitate of caseine produced by dilute hydrochloric acid can be re-dissolved by the addition of a certain quantity of the same acid. Lactic acid does not re-dissolve the precipitate which it at first occasions. Boiled milk is not increased in digestibility by the process, though the author recommends boiling as destructive to ferments and germs. Butter-milk is preferable to sweet milk as an article of diet, the lactic acid being first neutralised with lime-water. An addition of barley-water (1 part to 2 of milk) greatly increases digestibility. A child fed upon this mixture was found to utilise 99.75 per cent of the albumenoids, 96.6 of the fatty matter, and the whole of the sugar. —*Biedermann's Centralblatt*.

PAPERS UPON INDUSTRIAL CHEMISTRY.

By Prof. ALBERT R. LEEDS.

I. THE ANALYSIS OF SOAP.

In the analysis of soap it is necessary to determine:—

1. Water; 2. Uncombined fat; 3. Soap, consisting of (3a) combined fatty acids and (3b) combined alkali, usually soda (Na_2O); 4. Uncombined alkali; 5. Glycerine; 6. Resin; 7. Sodid carbonate; 8. Sodid chloride; 9. Sodid sulphate; 10. Sodid silicate, consisting of (10a) soda combined in silicate, (10b) silica; 11. Starch; 12. Insoluble residue or mineral impurities, such as talc, clay, ochre, sand, &c.

Methods of Analysis.

Various methods have been proposed, which can be best understood by presentation in the original language of their authors, along with such comments as have been suggested by my own experience. These notes are bracketed to distinguish them from the original text. In conclusion, I have ventured to propose a new method, which has been found to give accurate and rapid results, and has the advantage of reducing the performance of a soap analysis to a few consecutive operations and one weighing of the original sample.

Method I. (Published by C. F. C. in the *CHEMICAL NEWS*, vol. xxxv., p. 2.)

Weighing.—In all methods usually given in text-books the analyst is directed to weigh out for each operation small portions (1 to 5 grms.) of the sample. This plan is to be avoided, and for two reasons: 1. Soap is extremely variable in composition, and considerable variations are possible even in the same sample. 2. It is perpetually losing water by evaporation from its surface. As the soap is usually weighed in the form of thin shavings, the surface exposed is, in relation to the weight taken, very considerable.

[When the variations in composition are so excessive, analyses of more than one sample are necessary. With reasonable care the weight does not alter so rapidly in making thin shavings as to produce an appreciable error.—L.]

These two sources of inaccuracy are obviated by weighing out for the analysis a section cut through the bar at right angles to its length (60 to 80 grms.), dissolving in distilled water, and making the volume up to 1000 c.c. (in the cold); 50 c.c. of this solution are measured off for each operation. It should be observed that as some of the alkaline salts of the fatty acids separate out from the solution on cooling, it must be well mixed, by agitation, previously to drawing off each 50 c.c. The several operations are conducted as follows:—

1. *Total Alkali.*—50 c.c. of the solution are diluted to about 200 c.c., the liquid is coloured faintly with eosine, and standard acid is run in, taking care to stir briskly with a glass rod. The neutral point is extremely well marked by the sudden decolouration of the whole. The cause of this apparent destruction of colour is the union of the fatty acids with the eosine at the moment of their complete separation from the fluid.

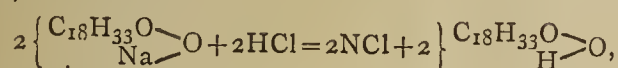
2. *Uncombined Alkali.*—50 c.c. are added to 300 c.c. of a saturated solution of common salt, which must be, of course, neutral to test-paper, and the volume made up to 400 c.c. The neutral alkaline salts of the fatty acids (*i.e.*, true soap) are precipitated; any excess of alkali present remains in solution; this is determined in an aliquot part of the filtered solution; the filter must not be moistened previous to filtration; from this the total uncombined alkali is calculated, and subtracted from the *total alkali* already found. Then the *combined* and *uncombined* alkali are determined.

3. *Fatty Acids.*—50 c.c. of this solution are introduced into a stoppered separating funnel, decomposed with ex-

cess of acid, and agitated with carbon disulphide until the liberated fatty acids are dissolved. The disulphide solution of the fats is drawn off into a tared flask; the aqueous solution is washed once or twice with small portions of disulphide, the whole of which is then separated from the fats by distillation. The fats are purified from the last traces of CS_2 by heating the flask for a short time at 100°C .; the weight, after cooling, less the tare, gives the weight of the fatty acids. Ordinary ether may be used in place of the CS_2 ; it has, however, the disadvantage of retaining small quantities of water, and therefore aqueous acids, which must be driven off at the end of the operation by exposing to a temperature of 100° to 120°C ., until the weight is constant. Further, the ethereal solution will be the upper stratum, and is, for obvious reasons, not so easily to be manipulated as the bisulphide solution, which forms the lower layer.

[The solution of the combined fatty acids in carbon disulphide is unnecessary, since they can be directly determined in the manner detailed further on.—L.]

Note.—A moment's consideration of the following equation, representing the decomposition of sodic oleate by HCl ,—



will make it evident that while the fatty acid is present in the soap in the form of anhydride, it is separated and weighed in the course of analysis as hydrate. A correction must therefore be applied, based upon the fact that 282 parts oleic hydrate = 273 parts oleic anhydride, *i.e.*, the weight of the fatty acids is to be multiplied by the decimal fraction 0.97.

In the case of the "olein" soaps of commerce, a very rapid and tolerably accurate estimation may be made in the following way:—50 c.c. of the solution are decomposed with HCl in a small flask, the neck of which is long and narrow, and graduated in c.c., and so much water added that, upon heating in the water-bath, the separated oil will rise into the neck and fall entirely within the graduated portion. The heating must be continued, with occasional tapping of the flask, until the whole of the fat has been separated and has risen into the neck. The flask is allowed to cool, and when cool the volume of the oil is read off. This quantity, multiplied by the specific gravity of the oil, gives its weight. The specific gravity (which I have almost always found to be 0.9) may be determined by pouring off a small quantity into a capsule (a second reading will give the volume taken), and weighing it; the weight divided by the volume is the required specific gravity.

4. *Water*.—If the purity of the sample has been ascertained this constituent may be calculated by difference. The direct estimation is effected by evaporating 50 c.c. of the solution to dryness on the water-bath (finally in the air-bath from 100° to 120°C .) in a weighed dish. The residue is anhydrous soap; from its weight the percentage of water in the soap may readily be calculated. It may be observed that the usual method, which consists in the exposure of the soap, previously cut into thin shavings and weighed, to the temperature of boiling water until it ceases to lose weight, is inaccurate, as it fails to drive off the last portions of water (1 to 2 per cent), which seem to have contracted a stronger union with the soap.

[This difficulty is not experienced if the soap is dried at 110° to constant weight. See also remarks by author of Method II.—L.]

5. *Mineral impurities and unsaponified fat* may be detected by taking the dry soap from the preceding operation, dissolving in strong alcohol, and filtering through a funnel heated by means of a jacket of hot water. *Mineral impurities* remain upon the filter as an insoluble residue, the weight of which is readily ascertained. The alcoholic filtrate is evaporated with successive additions of distilled water; by these means any unsaponified fat or resin is separated from the soap, which, of course, remains in

aqueous solution. This solution may be used for 1, 2, or 3. The mineral impurities may be examined qualitatively after drying and weighing.

[This method of determining the uncombined fat is tedious and troublesome, and furthermore has the disadvantage of not separating the resin from the fat.—L.]

Method II. (By C. Hope, in CHEMICAL NEWS, vol. xliii., page 219.)

In this paper I intend giving, for the full analysis of soda soaps, a method which I have used for some considerable time, and which I find to be useful in giving information as to how the soap has been made, and also as giving an exact analysis of it, which is much desired by some consumers, and not usually done by analysts. In some cases a much shorter analysis will suffice, but in a soap-works' laboratory the full one will be very often wanted. Before weighing off portions of the soap, I think it is absolutely necessary to cut off the outer skin and take the inside, otherwise discrepancies will result not otherwise to be accounted for. The skin is a very small portion usually of the bar or cake, and it would be a difficult operation to get the proper amount of skin in the different portions weighed.

[As compared with Method I., which necessitates but one weighing of the original sample, this method has the great disadvantage of necessitating no less than seven weighings of the sample, and in quantities varying from 5 to 31 grms. Besides the loss of time thus occasioned, there is a corresponding probability of the various determinations not agreeing among themselves, if the original sample was not uniform.—L.]

Water.—The first thing to be done is to cut some thin shavings of the sample, weighing about 5 grms., and place them in a small tared flat porcelain basin, and the exact weight noted. It is then put in the water-bath and heated until it ceases to lose weight; a night generally suffices for this purpose. When that is done, it is weighed in the morning, and a number of small holes made with a pin in the dried slices, and put in the bath again for a few hours, and re-weighed. If there is no further loss, as is generally the case, it is certain the soap is thoroughly dry. Some chemists have condemned this method of estimating the water, because, they say, it fails to give off the last 1 or 2 per cent; but I find that such is not the case, because when a soap is dried as I have described, it will give no further loss, even if heated to its decomposing-point.

Fatty Acids.—A portion of the soap, weighing about 5 grms., in the form of miniature bars, is introduced into a separating funnel of about 120 c.c. capacity, and about 50 c.c. of water at, say, 100°F . poured in, then enough acetic acid to decompose the soap and leave a small excess, and, finally, about 50 c.c. of ordinary ether. The stopper is then put in the funnel, and the whole shaken until the soap is all dissolved. It is then allowed to settle for a few minutes, when the fatty acids will be found to have dissolved in the ether, and floating on the watery solution, which contains the soda salts, &c. The bottom stopper is then opened slightly, and the watery solution of the salts allowed to drop slowly out until it stops; then the top stopper is taken out, and the remainder of the water allowed to drop slowly out until only a few drops remain, at which time the stopper is shut. The funnel is then filled up with water about 90° or 100°F ., the stopper replaced and shaken for a minute or so, allowed to settle, and the same operation as before repeated. The washing is continued until the washings are neutral, at which point the last few drops are allowed to go out, taking care not to allow any of the ethereal solution to follow it. It is always necessary to open the bottom stopper first, as there is enough ether vapour in the funnel to cause an outward pressure, which, on opening the top stopper, first causes a few small drops of the ether solution to splutter out—a proceeding not to be desired, and which is effectually prevented by operating as described. The dropping of the washings is to be carefully done, other-

wise the washings will be found to have a skin of fatty acid floating on the surface, which, of course, would cause a low result, and therefore must be carefully guarded against. The ethereal solution of the fatty acids is then poured out by the top of the funnel into a previously tared beaker of about 150 c.c. capacity, and the funnel rinsed out with fresh ether. The beaker is then covered with filter-paper and placed on the top of the water-bath until the ether is evaporated. If the odour still remains in the beaker, a few minutes inside the bath removes it completely. If the water has not been completely removed from the funnel a few small drops of water will be seen in the fatty acids, and may be removed by the addition of a few drops of absolute alcohol, and then heated inside the water-bath until its odour is gone. The beaker is now cooled and weighed, and, when the tare is deducted, gives the weight of fatty acids in the quantity of soap taken.

[This has the same objections as the extraction with carbon disulphide given in the original plan stated in Method I. See also C. F. C.'s objections to the use of ether instead of carbon disulphide.—L.]

Total Alkali.—For this determination I take 31 grms. of the soap, and put it into a 500 c.c. flask, and dissolve with the aid of heat in hot water. 50 c.c. of standard sulphuric acid are then added, and the flask filled up to the mark: 100 c.c. are filtered off, put into a beaker, and titrated with standard pure caustic soda, using litmus as an indicator. The acid used is a normal one—1 c.c. = 0.062 grm. Na_2O : and the soda used is one-tenth of that strength—1 c.c. = 0.0062 grm. Na_2O .

Sodic Chloride.—To the above neutralised solution some solution of yellow chromate of potash is added, and then titrated with a decinormal solution of silver, 1 c.c. = 0.00585 grm. NaCl .

Free Alkali.—31 grms. of the sample in thin shavings are weighed off and dissolved in rectified alcohol, then filtered as rapidly as possible, and the insoluble matter washed with boiling alcohol. A few drops of alcoholic solution of phenol-phthalein are added to the filtrate, and then titrated with the decinormal acid. This gives the free alkali existing as hydrate, usually only a trace or none.

Soda existing as Silicate and Carbonate.—The part insoluble in alcohol is dissolved on the filter with hot water, carbonic acid passed into the filtrate to precipitate a trace of lime usually in it, then thoroughly well boiled and filtered. The filtrate is then titrated with the decinormal acid, using litmus as indicator.

Soda existing as Carbonate.—5 grms. of the soap are dissolved in rectified alcohol, washed as before, and the insoluble dissolved in water. The solution containing the carbonate and silicate is put into a flask fitted with a set of two U-tubes containing solution of baric hydrate, and decomposed with dilute acid, and the CO_2 boiled out into the U tubes. The baric carbonate is filtered off as quickly as possible, the excess of hydrate washed from it, and the precipitate titrated with standard decinormal acid.

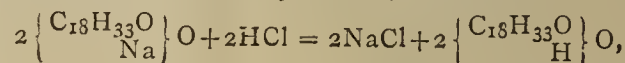
Sulphate of Soda.—10 grms. of the soap are dissolved in water, decomposed with HCl , and the fatty acids filtered off. The filtrate is precipitated with BaCl_2 , and finished in the usual manner.

Silica.—25 or 50 grms. are ignited in a platinum basin, and the residue treated with HCl , evaporated to dryness, re-treated with HCl , and the insoluble silica filtered off, ignited, and weighed.

Lime, Iron, &c.—The filtrate from the silica is made alkaline with ammonia, some oxalate of ammonia added, the precipitate collected, ignited, and weighed.

Calculation and Statement of Results.—The water, silica, lime, &c., and sodic chloride are simply calculated to per cent. The barium sulphate is calculated to per cent of sodic sulphate. The alkali soluble in alcohol is calculated to NaHO , and the acid used for titrating the baric carbonate to sodic carbonate. The "soda existing as carbonate" is deducted from the "soda existing as silicate and car-

bonate," and the difference stated as "soda existing as silicate." The silica cannot be stated as silicate of soda, because the "silicate" as used, and as it exists in the soaps, is not a normal one. It has an approximate composition of $\text{Na}_2\text{O}_2\text{SiO}_2$, but it is evidently not a definite compound; so that, under those circumstances, it is necessary to state the silica as such, and give the soda existing with it. It was pointed out by a writer in the *CHEMICAL NEWS* some years ago, and seems to be still ignored, that, although in the process of analysis the fat is separated and weighed as fatty acid, it exists in the soap as fatty anhydride, as the following reaction, representing the decomposition of sodic oleate by an acid, shows:—



and that by multiplying the fatty acids by the factor 97, the true weight of fatty matter existing in the soap was found. If the fatty acids are stated in the analysis, it will be found the analysis will total to nearly 102; therefore, because the per cent of fatty acids are usually wanted, I generally report the analysis in the following manner:—

	Per cent.
* Fatty anhydride
Soda existing as soap
Water
Sodic carbonate
„ hydrate
„ chloride
„ sulphate
Silica
Soda existing as silicate
Lime, &c.

* = Per cent fatty acids. Per cent total soda.

There are two other important points in connection with soap analysis, viz., the determination of the resin, and the melting-point of the fatty acids, that I intended to speak of in this paper, but I have not been able to get the experiments finished, so that I must leave them for a future communication. A method for the accurate determination of resin in soap, whether easy of execution or otherwise, is a thing still wanted. I have been working lately at a method which, although not a quick one, promised well for accuracy, and which I now find to give results short of the truth, because of the different resinic acids in resin having different solubilities in certain reagents.

(To be continued.)

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Professor of Chemistry and Physics in the University of Cincinnati.

SILVER, POTASSIUM, SODIUM, CHLORINE, BROMINE, IODINE, AND SULPHUR.

Continued from p. 43).

THE percentage of silver in silver sulphate has been determined by Struve and Stas. Struve† reduced the sulphate by heating in a current of hydrogen, and obtained these results:—

5.1860 grms. Ag_2SO_4 gave	3.5910 Ag.	69.244 per cent.
6.0543	4.1922	69.243
8.6465	5.9858	69.228
11.6460	8.0608	69.215
9.1090	6.3045	69.212
9.0669	6.2778	69.239

Mean, 69.230 \pm 0.004

* Smithsonian Miscellaneous Collections. "The Constants of Nature."

† *Ann. Chem. Pharm.*, 80, 203. 1851

Stas* working by essentially the same method, with from 56 to 83 grms. of sulphate at a time, found these percentages:—

69.200
69.197
69.204
69.209
69.207
69.202

Mean, 69.203 \pm 0.0012

Combining this mean with that from Struve's series we get a general mean of 69.205 \pm 0.0011.

The third and last sulphur ratio with which we have now to deal is one of minor importance. When silver chloride is heated in a current of sulphuretted hydrogen the sulphide is formed. This reaction was applied by Berzelius† to determining the atomic weight of sulphur. He gives the results of four experiments; but the fourth varies so widely from the others that I have rejected it. I have reason to believe that the variation is due, not to error in experiment, but to error in printing; nevertheless as I am unable to track out the cause of the mistake, I must exclude the figures involving it entirely from our discussion.

The three available experiments, however, give the following results:—The last column contains the ratio of silver sulphide to 100 parts of chloride.

6.6075 grms. AgCl gave	5.715 Ag ₂ S.	86.478
9.2323	7.98325 "	86.471
10.1775	8.80075 "	86.472

Mean, 86.4737 \pm 0.0015

We have also a single determination of this value by Svanberg and Struve.‡ After converting the chloride into sulphide they dissolved the latter in nitric acid. A trifling residue of chloride, which had been enclosed in sulphide, and so protected against change, was left undissolved. Hence a slight constant error probably affects this whole ratio. The experiment of Svanberg and Struve gave 86.472 per cent of silver sulphide derived from 100 of chloride. If we assign this figure equal weight with the results of Berzelius, and combine, we get a general mean of 86.4733 \pm 0.0011.

For sodium there are but two ratios of any definite value for present purposes. The early work of Berzelius we may disregard entirely, and confine ourselves to the consideration of the results obtained by Penny, Pelouze, Dumas, and Stas.

The percentage of oxygen in sodium chlorate has been determined only by Penny,|| who used the same method which he applied to the potassium salt. Four experiments gave the following results:—

45.060
45.075
45.080
45.067

Mean, 45.0705 \pm 0.0029

The ratio between silver and sodium chloride has been fixed by Pelouze, Dumas, and Stas. Pelouze§ dissolved a weighed quantity of silver in nitric acid, and then titrated with sodium chloride. Equivalent to 100 parts of silver he found of chloride:—

54.158
54.125
54.139

Mean, 54.141 \pm 0.0063

By Dumas* we have seven experiments, with results as follows:— The third column gives the ratio between 100 of silver and NaCl.

2.0535 grms. NaCl =	3.788 Ag.	54.211
2.169	4.0095 "	54.097
4.3554	8.0425 "	54.155
6.509	12.0140 "	54.178
6.413	11.8375 "	54.175
2.1746	4.012 "	54.202
5.113	9.434 "	54.187

Mean, 54.172 \pm 0.0096

Stas,† applying the method used in establishing the similar ratio for potassium chloride, and working with salt from six different sources, found of sodium chloride equivalent to 100 parts of silver:—

54.2093
54.2088
55.2070
54.2070
54.2070
54.2060
54.2076
54.2081
54.2083
54.2089

Mean, 54.2078 \pm 0.0002

Now, combining these three series, we get the following result:—

Pelouze	.. .. .	54.141 \pm 0.0063
Dumas	.. .. .	54.172 0.0096
Stas	.. .. .	54.2078 0.0002

General mean .. 54.2076 \pm 0.0002

Here the work of Stas is of such superior excellence that the other series might be completely rejected without appreciably affecting our calculations.

We have now before us the data establishing, with greater or less accuracy, twenty different ratios relating to the atomic weights of the seven elements under discussion. In these we are to discuss the results of about 250 separate experiments. Before beginning upon our calculations we will tabulate our ratios, and number them for convenient future reference. Of course it will be understood that the probable errors given below relate to the last term of each proportion:—

(1.)	Percentage of O in	KClO ₃	..	39.154	0.00038
(2.)	"	KBrO ₃	..	28.6755	0.00207
(3.)	"	KIO ₃	..	22.473	0.0050
(4.)	"	NaClO ₃	..	45.0705	0.0029
(5.)	"	AgClO ₃	..	25.0795	0.0010
(6.)	"	AgBrO ₃	..	20.349	0.0014
(7.)	"	AgIO ₃	..	16.9771	0.0009
(8.)	"	Ag in Ag ₂ SO ₄	..	69.205	0.0011
(9.)	Ag	: NaCl	:: 100	: 54.2076 \pm 0.0002	
(10.)	Ag	: KCl	:: 100	: 69.1032	0.0002
(11.)	Ag	: KBr	:: 100	: 110.3459	0.0019
(12.)	Ag	: KI	:: 100	: 153.6994	0.0178
(13.)	Ag	: Cl	:: 100	: 32.8418	0.0006
(14.)	Ag	: Br	:: 100	: 74.0809	0.0006
(15.)	Ag	: I	:: 100	: 117.5345	0.0009
(16.)	Ag	: Ag ₂ S	:: 100	: 114.8581	0.0006
(17.)	KCl	: AgCl	:: 100	: 192.294	0.0029
(18.)	AgCl	: AgBr	:: 100	: 131.030	0.023
(19.)	AgCl	: AgI	:: 100	: 163.733	0.0076
(20.)	AgCl	: Ag ₂ S	:: 100	: 86.4733	0.0011

* "Aronstein's Translation," pp. 214-218.

† "Berzelius's 'Ehrbuch,'" 5th edition, vol. iii, p. 1187.

‡ Journ. f. Prak. Chem., 44, 320. 1848.

§ Phil. Trans., 1839, p. 25.

§ Comptes Rendus, 20, 1047. 1845.

* Ann. Chem. Pharm., 113, 31. 1860.

† "Aronstein's Translation," p. 274.

Now, from ratios 1 to 7 inclusive, we can at once, by applying the known atomic weight of oxygen, deduce the molecular weights of seven haloid salts. Let us consider the first calculation somewhat in detail.

Potassium chlorate yields 39.154 per cent of oxygen and 60.846 per cent. of residual chloride. For each of these quantities the probable error is ± 0.00038 . The atomic weight of oxygen is 15.9633 ± 0.0035 , so that the value for three atoms becomes $47.8899, \pm 0.0105$. We now have the following simple proportion:— $39.154 : 60.846 :: 47.8899 : x$, = the molecular weight of potassium chloride = 74.4217 . The probable error being known for the first, second, and third term of this proportion, we can easily find that of the fourth term by the formula given in our introduction. It comes out ± 0.0164 . By this method we obtain the following series of values, which may conveniently be numbered consecutively with the foregoing ratios:—

(21.) KCl, from (1.)	=	74.4217 ± 0.0164
(22.) KBr, " (2.)	=	$119.117 \quad 0.0962$
(23.) KI, " (3.)	=	$165.210 \quad 0.0529$
(24.) NaCl, " (4.)	=	$58.366 \quad 0.0137$
(25.) AgCl, " (5.)	=	$143.062 \quad 0.0320$
(26.) AgBr, " (6.)	=	$187.453 \quad 0.0432$
(27.) AgI, " (7.)	=	$234.195 \quad 0.0530$

With the help of these molecular weights we are now able to calculate eight independent values for the atomic weight of silver:—

First, from (10) and (21),	Ag =	107.696 ± 0.024
Second, " (11) " (22.),	"	$107.948 \quad 0.087$
Third, " (12) " (23.),	"	$107.488 \quad 0.037$
Fourth, " (9) " (24.),	"	$107.671 \quad 0.025$
Fifth, " (13) " (25.),	"	$107.694 \quad 0.024$
Sixth, " (14) " (26.),	"	$107.681 \quad 0.025$
Seventh, " (15) " (27.),	"	$107.659 \quad 0.024$
Eighth, " (8) " (16.),	"	$107.712 \quad 0.025$

General mean .. 107.675 ± 0.0096

It is noticeable that six of these values agree very well. The second and third, however, diverge widely from the average, but in opposite directions; they have, moreover, high probable errors and consequently little weight. Of these two, one represents little and the other none of Stas' work. Their trifling influence upon our final results becomes curiously apparent in the series of silver values given a little further along.

When we consider closely, in all of its bearings, any one of the values just given, we shall see that for certain purposes it must be excluded from our general mean. For example, the first is derived partly from the ratio between silver and potassium chloride. From this ratio, the atomic weight of one substance being known, we can deduce that of the other. We have already used it in ascertaining the atomic weight of silver, and the value thus obtained is included in our general mean. But if from it we are to determine the molecular weight of potassium chloride, we must use a silver value derived from other sources only, or we should be assuming a part of our result in advance. In other words, we must now use a general mean for silver from which this ratio with reference to silver has been rejected. Hence the following series of silver values, which are lettered for reference:—

A.	General mean from all eight	107.675 ± 0.0096
B.	" rejecting the first	$107.671 \quad 0.0105$
C.	" " second	$107.671 \quad 0.0097$
D.	" " third	$107.679 \quad 0.0100$
E.	" " fourth	$107.675 \quad 0.0104$
F.	" " fifth	$107.671 \quad 0.0105$
G.	" " sixth	$107.674 \quad 0.0104$
H.	" " seventh	$107.678 \quad 0.0105$
I.	" " eight	$107.679 \quad 0.0104$

These values are essentially the same, both in magnitude and in weight. For all practical purposes any one of them is as good as any other. Still, on theoretical grounds, it may be well to keep them distinct and separate in the remainder of this discussion.

(To be continued.)

THE CITY CHEMICAL TRADES.

A SPECIAL General Meeting of gentlemen interested in the chemical trades was held at the offices of the London Chamber of Commerce, 84 and 85, King William Street, E.C., on July 30th, at 2 o'clock. Mr. David Howard was in the chair, and there were present Messrs. T. Farmer Hall, W. Caudery, J. G. Johnson, G. H. Ogston, J. Denham Smith, H. R. Smith, William Newton (Cannon and Newton), John Blott, Lewis P. Fielder, D. W. Greenhough, W. K. Hopkin, Bernard Dyer, Rudolph Messel, George Pugh, C. Christopherson, W. G. Blagden, H. Lindley Trumann, Geo. Bennett (Geo. Bennett and Sons), H. B. Clarke, Thomas Tyrer, W. M. Ramlett, and Kenric B. Murray, Secretary.

The minutes of the previous meeting were read by the secretary and adopted, and applications from 20 firms interested in these trades were submitted by members present, and recommended for the adoption of the Council of the Chamber. The list of committee, as prepared by the Preliminary Sub-committee, was adopted unanimously, Mr. David Howard being nominated president, and Mr. John Blott vice-president. The names of five firms were added to the Drysalts' and Druggists Sub-section, bringing the total number of members of the committee, including the chairman, to 37.

It was decided to hold the meetings of the section monthly, on the last Wednesday of the month, at two o'clock, and that ten days' notice at least should be given to the secretary of all questions for discussion.

The meeting adjourned till the last Wednesday in October, so as to give the Council time to confirm the proceedings.

The Chemical Section, as now constituted, will be one of the most important and influential in the Chamber, and there is every prospect that it will be able to carry out successfully measures to obtain the adoption of some uniform system of chemical analysis. This is the first object of the section; and it is proposed to discuss this question exhaustively at the earliest possible date, to submit it to Chambers of Commerce throughout the country, and, finally, to draft a Bill to be submitted to Parliament. The revised list of the committee as proposed by the General Meeting is as follows:—

Chairman, David Howard, Esq.; Deputy-chairman, John Blott, Esq.

1. Analytical Chemists' Sub-section.

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2. Chemical Manufacturers' Sub-section.

Blott (J. & J. Blott & Co.), Eagle Chemical Works, Chrisp-street, Poplar, E.; Burt, Boulton, and Heywood, 64, Cannon-street, E.C.; Spencer, Chapman (Chapman, Spencer, & Co.), 36, Mark-lane, E.C.; T. Farmer Hall (Farmer, Thomas, & Co.), Dunster House, Mark-lane, E.C.; J. C. & J. Field, 15, Lambeth Upper Marsh, S.E.; A. E. Ford (Gibbs, James, & Co.) 16, Mark-lane, E.C.; F. C. Hills, (Hills, Clarke, & Co.) 17, Philpot-lane, E.C.; Hopkin and Williams, 16, Cross-street, Hatton-garden, E.C.; David Howard (Howard and Sons), 36, Lombard-

street, E.C.; Geo. Matthey (Johnson, Matthey, & Co.), Hatton Garden, E.C.; Johnson, John & Sons, 23, Cross-street, Finsbury, E.C.; Thos. Elborough (Lawes' Chemical Manure Company, Limited), 59, Mark-lane, E.C.; Thos. Tyrer (May & Baker), Garden Wharf, Battersea, S.W.; C. T. McAdam (Nitro-Phosphate and Odam's Chemical Manure Company, Limited), 116, Fenchurch-street, E.C.; E. W. Pontifex (Pontifex and Wood), Shoe-lane, E.C.; Price's Patent Candle Company, Limited, 31, Threadneedle-street, E.C.; G. Atkinson (Atkinson, George, and Co.), 66, Aldersgate-street, E.C.

3. Chemical Merchants' and Brokers' Sub-section.

G. M. Bauer, 59, Mark-lane, E.C.; George Bennett (Bennett, George, & Sons), 10 & 11, Mincing-lane, E.C.; W. G. Blagden (Blagden & Angus), 1, Fenchurch-avenue, E.C.; W. Caudery (Caudery, William, & Co.), 150 & 151, Fenchurch-street, E.C.; D. W. Greenhough, 9, Mincing-lane, E.C.; L. P. Fielder (Pokorny, Fielder, & Co.), 15, Fish-street hill, E.C.; G. J. Saunders, (W. C. Bacon) 14, Mincing-lane, E.C.; W. Tennant (Tennant, Charles, Son, and Co.), 9, Mincing-lane, E.C.

4. Drysalters and Druggists' Sub-section.

A. Preston; — Umney; John Moss; J. Skilbeck; Barron, Squire, and Co.; Burgoyne, Burbidges, and Co.

NOTICES OF BOOKS.

Life of Sir William E. Logan, Kt., LL.D., F.R.S., F.G.S., &c., First Director of the Geological Survey of Canada. Chiefly compiled from his Letters, Journals, and Reports. By BERNARD J. HARRINGTON, B.A., Ph.D., Professor of Mining in McGill University; late Chemist and Mineralogist to the Geological Survey of Canada. London: Sampson Low, Marston, Searle, and Rivington.

BEFORE us lies the record of a career in some respects probably unique. We have here a man certainly not educated for scientific pursuits, and spending his days up to the age of thirty-three in the counting-house of a London merchant. Yet, from the firm with which he is connected, having entered into speculations connected with copper-mining, we find him, as if touched by the wand of a fairy, transformed into an efficient metallurgist and miner, and a really eminent geologist. In one sense, therefore, his life may prove a bad lesson, as supporting the common delusion that a man may, if he needs it, "pick up" any branch of science at any time. If Logan succeeded by dint of a rare capacity, bodily and mental, for hard work, hundreds would, under similar circumstances, have failed completely. Nor is it difficult to perceive that if he had enjoyed a good chemical education the undertaking would have been more remunerative. One part, namely, of the speculation consisted in a patent for extracting copper from slags, which were to be worked over again. This process came to nothing, so that the capital sunk in the purchase of the invention, and of some millions of tons of old slags, was to a great extent sacrificed. But that part of the business which consisted in smelting copper according to the ordinary Welsh process and in coal-mining, proved successful. From getting coal, as we are told, he was led to examine the origin of this mineral and to study the structure of the Glamorgan coal fields. So indefatigably did he work that by the time he had resided two years at Swansea, and whilst attending most diligently to business, he had completed a geological map of the district which was adapted by Sir H. de la Beche for the Government Survey with high encomiums. His first great geological discovery was the demonstration that the coal-beds had been formed *in situ* and were not accumulations of drift wood, &c. He came to this conclusion from observing the invariable presence, under

each seam of coal, of a bed called by the local miners the "under clay." In these beds were found the remains of certain trees, then known as *Stigmariæ*, since proved to be roots of *Sigillariæ*, and in such position that they must evidently have grown on the spot. In 1837 he was elected a Fellow of the Geological Society, before which he read an account of his observations on the coal-beds. He took an active part in the management of the Royal Institution of South Wales, in which he filled the office of Geological Orator. When he left Wales and returned to Canada, his native country, he had already become widely and favourably known to the leading geologists of the day as an earnest and accurate worker. In 1842 the project of geological survey of Canada, which had been frequently brought forward, was at last carried into execution, and on the earnest recommendations of De la Beche, Sedgwick, Murchison, and others, Logan was appointed the Director. Though now in his forty-fourth year he entered at once upon this vast undertaking, and often with but scanty appliances he conducted it successfully till, in his seventy-second year, his failing strength compelled him to resign, to the universal regret of the Colonial Government and of the Canadian public. It is impossible for us in our narrow limits to give even a sketch of his investigations and of their results. He was evidently a stratigraphist, little given to theorising and not much versed in palæontology, or in mineralogy and chemistry, in which latter departments, after being annoyed by some incompetent assistants, he had the insight to secure the services of Dr. T. Sterry Hunt. His practical experience in mining and metallurgy often enabled him to assist all who were engaged in *bona fide* attempts to develop the mineral wealth of Canada, and, on the other hand, to expose those impostors who merely sought to prey upon the public. He was not unfrequently urged to give his opinion upon auriferous quartz. "On one occasion a number of specimens were shown to him by some speculators in the presence of intending purchasers of the property. Sir William's opinion was asked whether the glittering metal visible at the bottom of the little cavities in the quartz was really gold. 'No doubt of it,' said the unmoved critic, after eying it closely with a pocket magnifier. 'No doubt of it, and with this glass you can see the marks of the punch perfectly.' On another occasion he was pressed for an answer to the question whether there was not an enormous quantity of copper within an area described. He satisfied both the intending seller and the contemplating purchaser by the reply, 'There is an enormous quantity of copper—an enormous quantity; and it is my opinion that it will cost just a little more than it is worth to get it out.'"

Unlike the majority of modern biographies this work must be pronounced an interesting and well-written history of an honourable and useful life.

Elementary Treatise on Physics, Experimental and Applied for the Use of Colleges and Schools. Translated and edited from Ganot's "Elements de Physique" (with the author's sanction), by E. ATKINSON, Ph.D., F.C.S., Professor of Experimental Science, Staff College, Sandhurst. Eleventh Edition, revised and enlarged. London: Longmans, Green, &c.

GANOT'S Physics, in Dr. Atkinson's version, is so well established in public favour in this country that no discussion of its merits and no exposition of its leading features can be needed. The present edition is enriched with thirty-two pages of additional matter, and with thirty more illustrations. Among the alterations we note the account of the endosmose of gases, their effusion and transpiration, absorption and occlusion has been transferred to Book IV., chap. 2nd, whilst in its former place, Book III., chap. 3, stands the description of hydraulic tourniquets, turbines, &c. This transposition is a decided improvement. A notice of Twaddell's dydrometer, which is wanting in the original as well as in the previous English editions, is

now inserted, though its superiority over Beaumé's instrument is not explained. The statement that dilute alcohol becomes more concentrated if kept in a bladder, though it has for a long time passed current in text-books, is not in harmony with the most recent researches.

In Book V., treating on sound, we find no alteration calling for notice.

In Book VI., there is an account of Jolly's method for determining the expansion of gases. In treating of the formation of vapour in closed tubes the Editor gives a more complete explanation of the critical point than was found in the last edition, and he also adds a definition of vapour as "a gas at any temperature below its critical point." Hofmann's method for the determination of vapour-densities is inserted, and a paragraph is added on the relation of vapour-density to molecular weight and on dissociation.

The chapter on the steam-engine has been re-written.

In the book on Light we find a notice of Professor Rowland's results on diffraction spectra.

The most numerous additions and alterations, however, are to be found in the books dealing with Magnetism and Electricity. Thus we have additional matter on the Holtz machine, a more detail account of residual charges, a description of the bichromate battery, and of Niaudet's element, and of Incandescent lamps. The secondary batteries of Planté and Faure are figured and described at length. Matteucci's laws of induced currents, as found in the last edition, are omitted, but we have figures and descriptions of Pacinotti's ring and of the Brush dynamo-electrical machine. The chapter on the determination of electric constants has been greatly extended and improved. In short the work has been, as a whole, carefully brought up to the level of the most recent investigations.

The Retrospect of Medicine, being a Half-yearly Journal, containing a Retrospective View of Every Discovery and Practical Improvement in the Medical Sciences. Edited by W. BRAITHWAITE, M.D., and JAMES BRAITHWAITE, M.D. Vol. LXXXVII., Jan.—June, 1883. London: Simpkin and Marshall.

COMPARATIVELY little of the matter contained in this volume has a chemical interest. Dr. J. Murray Gibbes, of New Zealand, speaks favourably of the *Eucalyptus globulus* as a disinfectant. Dr. J. Cossar Ewart gives a partial explanation of the "milk epidemic" at Aberdeen. The milk suspected and the pus obtained, from abscesses in the patients, contained virulent bacilli. These, it appears, had been added to the milk along with water. The water used at the dairy previously to the epidemic passed through a large concrete cistern (fitted with a loose, rough wooden cover) fixed in the corner of the large cow-house immediately over the heads of the cows. The spores arrived along with the steamed hay used for food, and had thus ready access to the cistern. How they reached the tank in which the hay was steamed is unexplained.

Dr. F. J. B. Quinlan upholds filtration through spongy iron as a sure means of destroying disease germs—a conclusion which the eminent microscopist, Mr. Jabez Hogg, does not accept.

Dr. A. D. Macdonald is in favour of ammonium benzoate as a germ destroyer.

Dr. Oliver proposes certain test-papers for the detection of albumen in urine. The papers are prepared either with potassium ferrocyanide, potassium mercuric iodide, &c. As these reagents are inoperative except in strongly acidified urine, a slip of paper, saturated with citric acid, is added to the sample in a small test-tube, either along with or prior to the ferrocyanide papers. Dr. F. W. Pavy makes up potassium ferrocyanide and citric acid into small pellets, which he uses for the same purpose.

The papers "On our Present Knowledge of Fever," by Dr. W. Moxon, on the "Germ Origin of Disease," by Dr. Quinlan, and "A New Fact in the Pathology of Parasitic Organisms," by the Editor of the *Medical Times*,

though of great scientific interest, scarcely come within our legitimate scope. We fear Dr. Quinlan will fall under the ban of the Vegetarians for showing that herbivorous animals are more liable to phthisis than the carnivora.

Vichy and its Therapeutical Resources. By PROSSER JAMES, M.D., M.R.C.P. London: Baillière, Tindall, and Cox; Alexander and Shephard.

VICHY appears to be a gathering place of a number of different kinds of mineral waters, recommended in a variety of diseases and at present eagerly and hopefully quaffed by those who, having lived as they please, now suffer what they must. The principal ingredient in these springs, and the one to which their medicinal value is chiefly ascribed, is sodium bicarbonate. Corresponding salts of potassium, magnesium, and calcium are also present, but in much smaller quantities, and are, by the author, considered of little consequence in a medicinal point of view. Phosphates and arseniates are present in small quantities. The analysis of Bouquet here quoted make no mention of metallic sulphides or of sulphuretted hydrogen, the odour of which is distinctly recognised in the water of the "Park" spring. Prof. Tichborne, in his "Mineral Waters of Europe," detects traces of lithium chloride, on which Bouquet is silent.

The medical uses of the various springs and their supposed *modus operandi* are not fit subjects for our discussion.

CORRESPONDENCE.

FAST-RED OR ROCELLIN.

To the Editor of the Chemical News.

SIR,—After reading the report on the legal decision on the Badische Anilin and Soda Fabrik *versus* Levenstein, I find the expert made three sulphonations of *α*-naphthylamine, one with 80 per cent, one with 30 per cent, and one with 10 per cent of active sulphuric acid anhydride. According to chemical literature, naphthylamine can also be easily sulphonated with ordinary concentrated sulphuric acid; but in the Specification of the Patent, No. 786, 1878, this method is not described, or an example given, to produce the naphthylamine-sulphonic acids by the direct action of ordinary concentrated sulphuric acid, and therefore the case *adhuc sub judice lis est*.—I am, &c.,

AEQUUM ET BONUM.

PRIESTLEY AND LAVOISIER.

To the Editor of the Chemical News.

SIR,—It is certainly strange to see Mr. G. F. Rodwell—who formerly defended, in the *CHEMICAL NEWS*, Priestley's discovery of oxygen against the pretences set up in favour of Swedenborg—disparaging in a French review the great Englishman's greatest discovery, under cover of defending the absurd claims set up by and for Lavoisier.

I trust your sense of impartiality will permit me to briefly point out in your wide-spreading columns, with reference to Mr. Rodwell's article in the *Revue Scientifique*, (1) That, taken in connection with Priestley's own account, published in 800, Lavoisier's statement—"This air which MM. Priestley, Scheele, and myself discovered almost simultaneously"—most certainly *does* prove "that he laid a dishonest claim to the discovery of oxygen." Priestley's account is this—"Having made the discovery (of oxygen) some time before I was in Paris in the year 1774, I mentioned it at the table of M. Lavoisier, when most of the philosophical people in the city were present, saying it was

a kind of air in which a candle burned much better than in common air, but I had not then given it any name. At this all the company, and M. and Madame Lavoisier as much as any, expressed great surprise. I told them I had gotten it from precipitate *per se*; also from red lead; but Mr. Scheele's discovery was certainly independent of mine."

(2.) Lavoisier's name for the gas, "oxygen" (or acid generator), although now universally adopted, is well known to be founded upon a quite erroneous apprehension, and shows that he completely misunderstood the nature and capabilities of the gas he says he discovered; whilst, on the other hand, if Mr. Rodwell possessed or had access to any edition of Priestley's works, he would never have made such a totally incorrect and unwarranted statement as that attributing the supposition to the English philosopher that his discovery was "ordinary air containing nitrous corpuscles."

(3.) Candid philosophers, such as Dr. T. Thomson, writing at, or not long after, the time the events occurred, were much more likely to have hit the truth and to have formed a correct judgment than we can possibly be now, and throughout Europe (except in France) Lavoisier's "claims" in this respect are ignored. At the laboratories in Bonn and Heidelberg lately I saw busts of Priestley and Davy, but none of Lavoisier.—I am, &c.,

W. A. Ross.

Aston, W., July 29, 1883.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvi., No. 3, July 16, 1883.

Separations of Gallium.—Lecoq de Boisbaudran.—Will be inserted in full.

Brief Description of an Electric Counter.—J. Cauderay.—This instrument cannot be intelligibly described without the accompanying figure.

A New Theorem of Dynamic Electricity.—L. Thévenin.—A mathematical paper, incapable of useful abstraction.

Emersion Currents, and the Movement of a Metal in a Liquid and the Emersion Currents.—M. Krouchkoll.—If two electrodes of one and the same metal be plunged into a liquid, it is known that if one of them is moved within the liquid, there arises a current, the direction of which varies with the nature of the metal and of the liquid in contact. It is also known that if one of the electrodes is already placed in a liquid and the other is plunged in also, there is produced a current at the moment of immersion. The author finds that an electric effect of the same kind is obtained when one of the electrodes is withdrawn from the liquid: there is then produced a feeble emersion current. He announces a simple relation between these three kinds of current: The current produced by immersion is contrary in direction to that produced by movement; the emersion current has the same direction as the movement current.

New Oxide of Copper Battery.—F. de Lalande and G. Chaperon.—This battery is based upon the simultaneous use of copper oxide, caustic potassa, and zinc. In order to form with copper oxide depolarising electrodes, it is merely requisite to keep it in contact with a plate, or a vessel of iron or copper, forming the positive pole of the element. These elements may be made so as to have a great surface by using vessels of wrought- or cast-iron, which are not attacked by the exciting liquid. The

amalgamated zinc and the copper oxide are not acted upon by the alkaline solution. The battery is therefore constant. Its electromotive force is nearly 1 volt, and its internal resistance is very slight.

Density of Liquid Oxygen.—S. Wroblewski.—The most probable value is 0.895.

Salts of Aurous Oxide. Colorimetric Determination of Gold.—A. Carnot.—The author employs a solution of hydrogen phosphide, obtained by decomposing calcium phosphide with hydrochloric acid and receiving the gas in pure water. If this liquid is poured gradually into a very dilute solution of gold chloride, either pure or containing phosphoric or arsenic acid, there appears in it a fine rose colour. This colouration is therefore due not only to a complex salt of aurous and ferric oxides, but also to simple aurous salts. The presence of ferric oxide merely gives these salts greater stability. As regards the use of this reaction in the quantitative determination of gold, the author finds that if we employ progressively increasing proportions of gold (e.g., 0, 1, 2, 3, . . . 9, 10 tenths of a milligram.), and a constant volume of liquid (100 c.c.) the rose colouration becomes deeper and deeper. A scale of tints may thus be established. The degrees are very distinct up to 1 milligram.; above this point the colouration is too intense, so that it is necessary to operate on more dilute solutions. The liquid to be examined is treated in the same manner and in a similar phial, and compared with the former series in the manner usual in colorimetry. The simplest method of obtaining coloured solutions for comparison is the following:—Add to the neutral solution of gold chloride a drop of hydrochloric acid, one or two drops of solution of ferric chloride, and a few drops of arsenic acid diluted with water to 100 c.c.; add a small pinch of zinc powder, and shake up; let settle, and pour off the clear. In case of a gold ore which it is required to value rapidly, the author takes 10 to 30 grms. in fine powder; treats with *aqua regia*, dilutes, and filters to get rid of the gangue; evaporates to dryness, evaporates a second time with a little nitric acid, and heats to dull redness. The residue is treated with chlorine water, which dissolves the gold without attacking the ignited ferric oxide. After expulsion of the chlorine the liquid is ready for the colorimetric assay. The other metals most frequently present in gold ores, such as antimony, copper, zinc, &c., do not interfere with this process. The author recommends it, not as a substitute for the dry assay, but as a rapid and approximate method.

Alcoholate of Baryta.—M. de Forcrand.—The author has determined the heat liberated in the formation of this compound by the action of anhydrous baryta upon absolute alcohol.

Action of Aldehyd upon Propyl-glycol.—Arnaud de Gramont.—The author heats together equal weights of aldehyd and iso-propyl-glycol to 160° in a sealed tube, and obtains a new compound, probably propylen-acetal, $C_5H_{10}O_2$.

Researches on Cinchonamine.—M. Arnaud.—The author has examined the hydrochlorate, hydrobromate, hydriodate, nitrate, sulphate, formiate, acetate, oxalate, tartrate, malate, and citrate of this base.

A New Glycerin.—The compound in question is the mesitylenic glycerin, $C_6H_3(CH_2.OH)_3$.

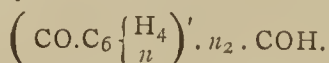
On Heating with Coal, with Conversion of its Nitrogen into Ammonia.—M. Scheurer-Kestner.—The author contends that the heat lost in the conversion of coal into coke and coal-gas (= 19.3, or nearly 20 per cent) outweighs the value of the ammonia produced, except when coal is very cheap. According to the results of Mr. Foster, which he quotes from the *Journal of the Chemical Society*, only 14.5 per cent of the nitrogen present in the coal is converted into ammonia, and 1.5 as cyanogen, the remainder either escaping as free nitrogen or remaining in the coke.

Journal für Praktische Chemie.

New Series, Vol. xxvii., Parts 10 and 11.

Contributions to the Chemistry of the Rhodium-ammonium Compounds.—S. M. Jörgensen.—A detailed account of the chloro-purpureo-rhodium chloride, nitrate, silico-fluoride, platinum-chloride, sulphate, and carbonate; the bromo-purpureo-rhodium bromide, nitrate, silico-fluoride, and platinum-bromide; the iodo-purpureo-rhodium iodide, the iodo-purpureo-rhodium chloride, nitrate, silico-fluoride, platinum-iodide, and sulphate; and the dichloro-terea-pyridin-rhodium chloride. The author then describes some preliminary experiments on the determination of the atomic weight of rhodium, for which purpose he considers the chloro-purpureo-rhodium chloride and the corresponding bromine compound, on account of their great permanence. His experiments have given the values 103.18 and 103.05, but his researches on this subject are being continued.

What is Isatine?—H. Kolbe.—The author regards isatine as nitro-benzoyl-formyl, *i.e.*, a compound of formyl with benzoyl, in the latter of which an atom of monovalent nitrogen is substituted for one of the atoms of hydrogen. Prof. von Meyer, on the other hand, regards isatine as benzoyl-nitro-carbinol—



Preparation of Symmetric Diphenyl-urea and Diphenyl-guanidine.—W. Hentschel.—On distilling a mixture of phenol sodium and ethyl-oxide carbanilate in proportions corresponding to their molecular weights, pure phenetol passes over at about 220°; the operation is best conducted in a current of hydrogen. The residual cake is repeatedly boiled with water, when sodium carbonate dissolves and diphenyl-urea remains in fine prisms, which are purified by re-crystallisation from hot alcohol. Pure diphenyl-urea is ground up with its equivalent of sodium ethylate, and heated to 220° in a current of hydrogen, when a clear oily distillate passes over, which proves to be pure aniline. The contents of the retort are dissolved in hot dilute hydrochloric acid. The solution is filtered, and a little fuming hydrochloric acid is added to the filtrate while still hot. On cooling the liquid congeals to a thick paste of yellow or grey crystals, which after re-crystallisation prove to be triphenyl-guanidine hydrochloride.

Thymol Derivatives.—A. K. Richter.—We have here an account of ethyl-thymyl carbonate, dithymyl carbonate, the behavior of sodium-phenylate and alcoholate with ethyl-thymyl carbonate, and the behaviour of the alkali-alcoholates with dithymyl carbonate.

Preparation of Acetamide and some other Amides of the Fatty Series.—Julius Schulze.—The author digests 1 mol. ammonium sulpho cyanide with 2½ mols. glacial acetic acid for three to four days. The yield does not fall far short of the theoretical quantity.

Preparation of Ammonium Sulpho-cyanide.—Julius Schulze.—The author gives, as the best proportions, 600 grms. alcohol at 95 per cent, 800 grms. ammonia at 0.912 sp. gr., to from 350 to 400 grms. carbon disulphide. Larger proportions of alcohol and ammonia do not increase the yield.

Novel Formation of Anthracene.—O. Henzold.—The author heats a mixture of benzyl-ethylether and phosphoric anhydride in a vessel fitted with a reflux condenser. When the violent reaction is over, he heats more strongly, and distils the product. The semi-solid distillate is freed by imbibition from undecomposed benzylic ether, and from an oil, the nature of which is not yet known. It is then repeatedly re-crystallised from glacial acetic acid, and finally purified by cautious sublimation. The product thus obtained is physically and chemically identical with pure anthracene from coal-tar.

Bulletin de la Société Chimique de Paris.

No. 1, July 5, 1883.

Researches on the Electrolysis of Sodium Chloride.—Laurent Naudin and A. Bidet.—The authors have undertaken their researches with a view to the application of the chlorine in bleaching. They set out with the supposition that with an apparatus suitably arranged it should be possible to recover and use over again almost the totality of the chlorine, which, except the losses incurred in washing the goods after bleaching, may thus serve indefinitely. After a prolonged course of experiments they conclude that this rotation of chlorine is possible with an apparatus properly arranged, and with a small electrolytic force. The mode of action of the current has a considerable influence upon the yield of total active chlorine. In certain cases this increase may extend to six-fold with the same electromotive force.

Certain Double Salts of Lead.—A study of the lead oxy-chlorides and oxy-bromides.

Azotometry in Ammoniacal Manures.—Wareg Massalski.—This important memoir cannot be reproduced without the accompanying illustration.

Russian Chemical Society.—Session November 4/16, 1882.—M. Poehl announces that almost all animal and vegetable tissues possess the property of transforming albumenoid matters into peptone.

M. Elkétoff sent in a communication on certain oxides of the series $\text{C}_n \text{H}_{2n} \text{O}$, most of which have not yet been studied.

M. Basaroff submitted a study on the oxidation of sulphur distributed on vines. The air above the vines thus treated contained sulphurous acid in the proportion of 0.004 per cent by volume, or 0.09 per cent by weight.

M. Orłowsky sent in analyses of the mineral waters of S'awinsk, which contain a large proportion of ferrous salts.

The same chemist communicates a note on the use of sodium hyposulphite in qualitative analysis in place of hydrogen sulphide.

M. Orloff has studied the hydrogenation of the essential oil of turpentine and of cymene.

MM. Markownikoff and Oglobine, by the action of chlorine upon the hydrocarbons $\text{C}_n \text{H}_{2n}$, occurring in the petroleum of the Caucasus, have obtained chlorinated compounds, $\text{C}_n \text{H}_{2n-1} \text{Cl}$.

M. Gustawson sent in papers on the cause of the effect produced by minimal quantities of aluminium chloride and bromide on the conditions of the transformation of normal propyl into isopropyl.

M. Alexeeff described the results of his thermic researches on the aqueous solutions of salicylic acid.

At the Session December 2/14, 1882, M. Konovaloff described his experiments on pyro-sulphuryl chloride (see *Comptes Rendus*, xv., p. 1284).

M. Sokoloff gave results of analyses of air obtained by means of his new eudiometer.

M. Almedingen communicated novel facts relative to the transformation of croonylene into a hydrocarbon corresponding in its properties to hexa-methyl-benzene.

M. Poehl has studied the putrefaction of flour, and the action of ergot upon the latter in order to detect the origin of the disease known as raphanie. This disease springs, according to the author, from the use as food of decomposing flour containing ergot. The injurious action of such flour is due to the ptomaines formed on the decomposition of the peptones derived from the albumenoid matter of the flour. As ergot possesses, according to the experiments of the author, the property of transforming albumenoid matters, it contributes indirectly to the formation of ptomaines in the flour.

M. Mendelejeff announces that the hydrocarbons of petroleum boiling between 30° and 40°, have, at +18°, a specific gravity of from 0.625 to 0.637, *i.e.*, the same as the hydrocarbons of Pennsylvanian petroleum having the same boiling-points. This fact is the more remark-

able as the hydrocarbons of American petroleum boiling above 40° , are less dense than the hydrocarbons of Baku, having the same boiling-point.

M. Mendelejeff also explained his ideas on the structure of benzol, and communicated his researches on the method of preparing a lighting oil, which may be used in lamps without danger.

MM. Beilstein and Kourbatoff communicate the results of their researches on the petroleum of the Caucasus. The petroleum of Baku contains chiefly hydrocarbons of the series $C_n H_{2n}$, identical with the products of the hydrogenation of the aromatic hydrocarbides, $C_n H_{2n-6}$. The petroleum of the so-called "Royal Wells" is composed principally of hydrocarbons $C_n H_{2n+2}$, with which are mixed hydrocarbons $C_n H_{2n-6}$; it contains also a very little of hydrocarbons $C_n H_{2n}$. American petroleum contains hydrocarbons $C_n H_{2n+2}$ and $C_n H_{2n-6}$, and a very small quantity of $C_n H_{2n}$. It contains also abundance of solid hydrocarbons (paraffins) not found in Russian petroleum. The lighting oil obtained from the petroleum of Baku has a higher specific gravity than that from American petroleum; it burns with a much brighter light, and contains hydrocarbons sensibly richer in carbon.

No. 2, July 20, 1883.

Note on the Crystallisation of Bodies at High Pressures.—MM. E. Jannettaz, Neel, and Clermont.—M. Friedel, having contested the announcement of M. Spring that a pressure of 5000 atmospheres exerted upon amorphous pulverulent matters causes them to become aggregated into crystalline masses, the authors determined to repeat his experiments, using pressures of from 6000 to 8000 atmospheres. They operated upon pulverised antimony, bismuth, zinc, iron, tin, copper, and lead; Darcet's alloy and brass, lead, and zinc sulphides, sodium lead and mercurous chlorides, mercuric iodide, magnesia, alumina, silica, chalk, and copper sulphate. All these powders were agglutinated into solid masses, but even those which acquired some degree of transparency were not crystallised. Many of the substances, however, such as steatite, graphite, clays, and metals, acquired a schistous structure, and assumed the thermic properties characteristic of such structure.

Thermic Study of the Solution of Hydrofluoric Acid in Water.—M. Guntz.—The author has determined the solution-heat of hydrofluoric acid in the gaseous and the liquid state, and the heat of this acid in different states of concentration.

Decomposition of Certain Organic Bodies by the Effluve.—M. Maquenne.—The bodies experimented upon are ethylic and metylic alcohols, acetic acid, acetone, and methyl formate. It seems permissible to conclude that the effluve acts in a manner quite similar to heat alone.

Presence of Mannite in the Pineapple.—L. Lindet.—In addition to 8.2 per cent of saccharose and 2.6 of reducing sugars, the author finds 1 per cent of mannite, calculated for the weight of the fresh fruit.

Observations on Duplo-thiacetone.—W. Spring.—The author studies the preparation of duplo-thiacetone and the formation of oxy-thiacetone; the behaviour of the former body with nascent hydrogen, the oxidation-products of oxy-thiacetone and of the accompanying bodies, and their behaviour with chlorine.

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MUNRO SCOTT, Warden.

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22, ALBEMARLE STREET, LONDON, W.

The next ANNUAL GENERAL MEETING will be held at SOUTHPORT, commencing on WEDNESDAY, September 19.

President-Elect:—

ARTHUR CAYLEY, Esq., M.A., LL.D., F.R.S., V.P.R.A.S., Sadlerian Professor of Mathematics in the University of Cambridge.

NOTICE TO CONTRIBUTORS OF MEMOIRS.—Authors are reminded that, under an arrangement dating from 1871, the acceptance of Memoirs, and the days on which they are to be read, are now, as far as possible, determined by Organising Committees for the several Sections before the beginning of the Meeting. It has therefore become necessary, in order to give an opportunity to the Committees of doing justice to the several Communications, that each Author should prepare beforehand an Abstract of his Memoir, of a length suitable for insertion in the published Transactions of the Association, and the Council request that he will send it, together with the original Memoir, by book-post, on or before August 22, addressed thus:—"General Secretaries, British Association, 22, Albemarle Street, London, W. For Section" Authors who comply with this request, and whose Papers are accepted, will be furnished before the Meeting with printed copies of their Reports or Abstracts. If it should be inconvenient to the Author that his Paper should be read on any particular days, he is requested to send information thereof to the Secretaries in a separate note.

T. G. BONNEY, Secretary.

THE LONDON HOSPITAL and MEDICAL

COLLEGE, MILE END, E.—The SESSION 1883-4 will commence on Monday, October 1st, 1883, when the Prizes for the past Session will be distributed, after which there will be a Conversation, to which all past and present students are invited. **FOUR ENTRANCE SCHOLARSHIPS**, value £60, £40, £30, and £20, will be offered for competition at the end of September to new Students. Fees for Lectures and Hospital Practice, 90 guineas in one payment, or 100 guineas in three instalments. All resident and other Hospital appointments are free. The resident appointments consist of Five House Physiciancies, Five House Surgeoncies, and One Accouchurship; Two Dressers and Two Maternity Pupils also reside in the Hospital. Special entries may be made for Medical and Surgical Practice. The London Hospital is now in direct communication by rail and tram with all parts of the metropolis.

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The WINTER SESSION will open on MONDAY, OCTOBER 1, with an Introductory Address by Dr. HANDFIELD JONES, F.R.S., Senior Physician to the Hospital. The Choir at the Annual Dinner in the Evening, at Limmer's Hotel, George Street, Hanover Square, will be taken by Spencer Smith, Esq., F.R.C.S., Consulting Surgeon to the Hospital.

Four Open Scholarships in Natural Science, each of the value of £50, will be offered for competition on October 2 and following days.

The School buildings, to which large additions have been made, especially as regards the laboratories for the teaching of Physiology and Chemistry, will be ready for occupation on October 1; and it is intended to open on the same day a "Student's Club and Refectory Room," for the convenience of the Pupils of the Hospital, in the building itself.

In addition to the open Entrance Scholarships, Class Prizes, and usual Appointments, Scholarships will be offered for competition at the end of each year, open to all pupils of the Hospital. These Scholarships are of the value of £20, £25, and £30, for the first, second, and third years respectively.

Further information may be obtained of the Dean, or of the Medical Superintendent at the Hospital.

A. B. SHEPHERD, M.D., Dean of the School.

29th June, 1883.

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Solicitor for the said Company.

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AND
JOURNAL OF PHYSICAL SCIENCE.

Edited by WILLIAM CROOKES, F.R.S.

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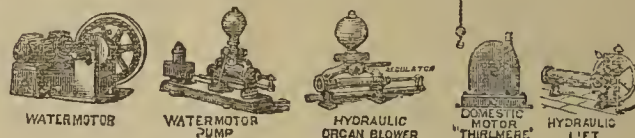
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A 20-horse Water Motor, pumping for H. Vivian, Esq., M.P.

A 12-horse Water Motor, pumping at the Mine of G. N. Newdegate, Esq., M.P.

TESTIMONIALS.

June 22, 1881.—From H. H. Vivian, Esq., M.P.—"I have just heard that the Water Motor sent out last year is doing well."

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THE CHEMICAL NEWS.

VOL. XLVIII. No. 1237.

PEMBERTON'S METHOD FOR THE VOLUMETRIC ESTIMATION OF PHOSPHORIC ACID.*

By Prof. G. C. CALDWELL.

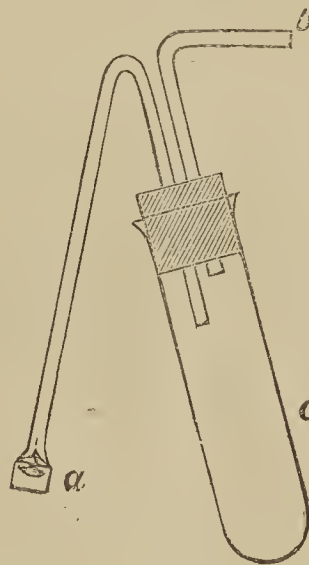
Mr. H. Pemberton, Jr., has described (*Journal Franklin Institute*, March, 1882, p. 184), a new method for the volumetric determination of phosphoric acid, especially in fertilisers, by a standard solution of ammonium molybdate; he adds the precipitant to the suitably prepared solution of the fertilisers as long as a precipitate is produced, the final tests for further precipitation being made with small filtered portions of the solution under examination. He prepares his standard solution by dissolving 89.543 grms. of ordinary ammonium molybdate in 1000 c.c. of water; each cubic centimetre of such a solution precipitates 3 milligrams of phosphoric anhydride. The solution of the phosphate is freed from silica and organic matter, then made up with as little excess of acid as possible, and just neutralised with ammonia; 2 c.c. of nitric acid (sp. gr. at least 1.4) and 10 grms. of ammonium nitrate are added, and the solution is heated to 60° C., or above, preparatory to adding the molybdate; it is necessary to apply the filtration test only towards the end of the operation, when it becomes difficult to discern the effect of further addition of the molybdate, even in the supernatant liquid that has been somewhat clarified by standing for a minute or two.

The frequent need of the determination of phosphoric acid in fertilisers, the absence of any thoroughly reliable volumetric method for this determination, and the length of time required for the gravimetric method, when the acid must first be precipitated by molybdate, all unite to give special interest to such a method as this, in which the molybdate itself, giving so sharp a reaction for the acid, is used directly in the standard solution.

With one modification in the preparation of the standard solution, and another and more important one in the mode of filtering out the test-portion, the process has satisfactorily sustained a series of careful tests in the laboratory of the University. As to the preparation of the standard solution, Pemberton found that the ordinary ammonium molybdate of the druggists was sufficiently pure to give the standard directly; in order to clear away the slight turbidity which the salt usually leaves he added a little ammonium hydrate. It was observed by Dr. Newbury, then analyst to the Station, that in the case of the molybdate supplied to us, a notable degree of alkalinity was communicated to the solution by the quantity of ammonium hydrate required to clarify it, and that, consequently, the necessary acidity produced by the nitric acid added in the beginning to the solution of the phosphate, became so much reduced towards the end of the titration after a considerable quantity of the molybdate had been added, that the results were unsatisfactory; in some instances the solution even became slightly alkaline before the precipitation was completed. In order to avoid this difficulty the molybdate solution was filtered after the addition of a few drops of ammonia at the most, and then standardised by a solution of phosphorus salt in which the phosphoric acid had been carefully determined by molybdate and magnesia mixture in the usual manner.

As to the manner of taking out the final test-portion, even when this operation is performed as described by

Mr. Pemberton, this method of determining phosphoric acid is unquestionably more expeditious than the usual precipitation method; but the necessity of filtering out each test-portion in the ordinary way through a filter has its evident objections. For this filtration we have used in this laboratory with entire success a little contrivance that was applied with like success some years since in the determination of sulphuric acid by a standard solution of barium chloride, in a modification of Wildenstein's method as described by Fresenius. The apparatus, as still further improved, more recently, is shown in the adjoining figure. The internal diameters of the bent tubes *a* and *b* should be about one millimetre, and that of the mouth at *a* about five millimetres. The length of the arm *a* may of course be adapted to the depth of the beaker used. To prepare the filter for use a small perforated platinum cone, or a tangle of fine platinum wire, is crowded into the throat of *a* so that it will not fall out when the mouth of the tube is downwards; suction is applied at *b* by a rubber tube to



the mouth or connected with the exhaust; *a* is dipped for an instant only in a very thin asbestos pulp, and the suction is continued while the filter is then plunged into water and till the wash water comes through clear; it is then ready for use.

In using it, the only precaution to be observed, and that is an essential one, is never to plunge the filter into a liquid unless suction is applied to it, and to continue the suction as long as it remains in the liquid; otherwise the asbestos and cone may fall out of the tube. The filter being thus withdrawn, the liquid contained in it and the tube *a* is drawn over into the test-tube; two or three drops of the molybdate solution are run directly into *c* to test for complete precipitation, the rubber cork and its two tubes being meanwhile conveniently hung on a hooked wire attached to the lamp stand; the test being completed by heating the contents of the test-tube just up to boiling, the liquid is poured back into the beaker and the tube is rinsed also into the beaker with a very little hot water; when the next test-portion is to be filtered out the first filtrate drawn over is poured back into the beaker, thus using this portion to wash out of the filter and tube the last portions of liquid adhering to it from the previous filtration. The final reaction is so sharp that, towards the end of the titration, we have found it sufficient to add to the solution in the beaker only the few drops of molybdate added to the test-portion.

In the following table the results are given of our tests of this method of determining phosphoric acid. The solutions of the phosphate analysed and of the molybdate were prepared by Dr. Newbury, and the gravimetric determinations by the ordinary molybdate method were also made by him. The several volumetric tests following were made, using these solutions, by Dr. Newbury (I.), Dr.

* *Journal of the Franklin Institute*, July, 1883. From advance sheets of the Second Report of the Cornell University Experiment Station.

Station. Number.	I.		II.	III.	IV.
	Grav.	Vol.	Vol.	Vol.	Vol.
235		13'14 13'14	13'27 —	— —	13'13 13'18 13'15 13'12
259	12'47 12'41	12'33 12'33	12'39 —	12'44 12'45 12'47	12'34
261	9'15 9'21	9'26 9'26	9'08 —	9'20 9'05 8'97 8'97	9'34 9'37
272	13'69 13'82	13'57 13'57 13'69 13'69 13'63	13'75 — —	13'82 13'81 13'72	

S. M. Babcock (II.), then instructor in the chemical department, and myself (III.), and in every case in entire ignorance of the results obtained by the others. Mr. Furry (IV.), at present the analyst of the station, prepared his own solutions throughout.

Most of these results speak well in favour of the method, and it appears to be capable of greater accuracy than is here indicated; for in most cases, and apparently in accordance with Mr. Pemberton's directions, larger quantities of the molybdate were added between each test towards the close of the titration than were necessary; these additions should be made by 0.1 c.c. at the most. But the results obtained in the case of No. 261 do not agree closely enough hardly even for technical work; there seemed to be some source of error there which may be revealed by a further examination of the phosphate.*

I am permitted by Dr. S. M. Babcock, now chemist of New York State Experiment Station, to mention in this connection his good success in determining reverted acid by precipitation with magnesia mixture from the ammonium citrate solution, according to Johnson's method, solution of the precipitate in nitric acid, and titration with standard molybdate.

[The yellow phospho-molybdate has frequently been used as a basis of calculation in determining small quantities of phosphorus in analyses of iron and its ores. But never, to my knowledge, has it heretofore been successfully employed where large percentages of P_2O_5 were to be determined. Previous to the investigations of Dr. Gibbs, on the phospho-molybdates, many chemists were in doubt as to whether the yellow precipitate, with its extraordinary formula, actually was a definite chemical compound or not. Different analyses of it varied as much as 30 per cent on the total P_2O_5 contained therein. Eggertz and Finkner showed how the precipitate could be formed so as to vary in per cent P_2O_5 within moderate limits, and the phosphorus estimations in iron and steel were thereupon based upon the direct weighing of the yellow salt.

It appears to be an impossibility, however, to precipitate the pure yellow salt, with the ratio of MoO_3 to P_2O_5 exactly as 24 : 1, when the usual nitric acid solution of the molybdate is employed. Because the length of time during which the solution must stand in the heat, and the large excess of the precipitant required, cause more or less MoO_3 to fall with the precipitate.

* Since the publication of the above, Prof. Caldwell writes:—"To what appears in this report I might add that quite a number of additional analyses of the same fertilisers have since been made by my students, and with as good results as they get by any other method. I always use the suction filter described in the paper that you will receive, and which I think Mr. Pemberton will like as an auxiliary to his method."

It is very evident, therefore, if there is any tendency in the same direction when the aqueous molybdate solution is employed, that the volumetric process would be unreliable, and the error a radical one. Happily, however, there is no danger in this; there cannot possibly be an excess of the molybdate in the solution, except the fraction of a cubic centimetre at the very end of the titration. My original experiments, together with the subsequent experience of nearly three years, are corroborated by the above criticism of Prof. Caldwell, and they all go to prove the constancy and reliability of the process.

It may be worth noting that this is the only known volumetric process of determining phosphoric acid when iron or alumina are present, or when the solution is a nitric acid one.

The only drawback I have found—that of determining with quickness the final point of the reaction—has been very largely overcome by the happy idea of Prof. Caldwell, illustrated in his paper above.

It is evident that this little portable Bunsen filter can be used with advantage in many other volumetric methods of direct precipitation, and would doubtless give a practical nature to a variety of processes otherwise difficult or tedious.

HENRY PEMBERTON, Jr.]

SEPARATIONS OF GALLIUM.

By M. LECOQ DE BOISBAUDRAN.

Separation from Molybdenum.—This is effected by means of the following methods, the last of which is merely approximative and should be employed conjointly with one of the other two.

1. The hydrochloric solution, distinctly acid, is saturated in the cold with hydrogen sulphide. Molybdenum sulphide is deposited and is collected upon a filter and washed with water acidulated with hydrochloric acid and saturated with sulphuretted hydrogen. The filtrate, kept for some time at 70°, and then raised to a boil, yields a further deposit of molybdenum sulphide which is collected on a filter and washed with water acidified with hydrochloric acid. After these operations the liquid is still not free from molybdenum, and is therefore concentrated and again treated as above, until after saturation with hydrogen sulphide in the cold and subsequent boiling no brown colouration is produced.

When the volume of the liquid does not exceed a few c.c. The residue of molybdenum not precipitated by hydrogen sulphide may be entirely neglected, but when operating on a mixture containing much gallium and very little molybdenum, it is well to combine this process with that described under No. 3.

Red molybdenum chloride, and especially the blue chloride, are much more slowly precipitated by sulphuretted hydrogen than molybdic acid. Before treatment with sulphuretted hydrogen the lower compounds of molybdenum should be oxidised in heat, by means of a few drops of nitric acid, any excess of which will be destroyed by boiling with hydrochloric acid.

2. The precipitation of molybdenum sulphide is effected more rapidly as follows:—

The solution is supersaturated with ammonia and mixed with ammonium sulphide. Very quickly, especially at a gentle heat, there appears a yellowish-red colouration; the mixture is then supersaturated with dilute hydrochloric acid, which precipitates molybdenum sulphide. It is heated gently until the sulphuretted hydrogen is expelled, filtered, and washed with dilute hydrochloric acid.

But little molybdenum remains in the filtrate; to remove it the bulk of the liquid is reduced, destroying the ammoniacal salts by boiling with aqua regia, and the pro-

duct is treated like the original solution. Generally, after two operations thus conducted, there remains but very slight traces of molybdenum mixed with the salt of gallium; in an exact analysis the following process must be adopted:—

In spite of good washings with dilute hydrochloric acid, the molybdenum sulphide obtained as above retains a very small quantity of gallium. To be exact it is re-dissolved in aqua-regia, the nitric acid is expelled and the former treatment is repeated. As in the method No. 1, the red and blue chlorides must be previously converted into molybdic acid.

3. The solution is mixed with sulphuric acid and ammonium sulphate in quantities slightly greater than are necessary to form alum with the whole of the gallium. If the metals are not already in the state of chlorides a little hydrochloric acid is added and the solution is concentrated until crystals of alum appear on cooling; a very little hydrochloric acid is added, and the mass is agitated with three or four volumes of alcohol at 85 per cent. When the salt has been deposited it is collected on a filter, washed with alcohol at 85 per cent, and re-dissolved in water. To the new solution is added a small fragment of ammonium bisulphate, and a few drops of hydrochloric acid; it is concentrated and then treated like the original liquid.

Two or three re-crystallisations of the alum effected in this manner are sufficient to free it from any appreciable trace of molybdenum. The separation succeeds with the red and the blue molybdenum chlorides, as well as with molybdic acid. The liquids containing the molybdenum are evaporated to expel the alcohol and treated by either of the processes 1 and 2. In an exact analysis we must begin by removing the greatest possible quantity of the molybdenum in the state of sulphide; concentrate strongly, transforming the greater part of the gallium into alum, and precipitate as sulphide the traces of molybdenum contained in the final concentrated solution. As the crystallisation of the alum may be effected with the salt derived from 0.01 grm. of gallium, we see that the quantity of molybdenum escaping the action of the processes Nos. 1 and 2 in so small a volume of liquid may be neglected.--*Comptes Rendus.*

ON THE ROUGH AND READY WAY OF ESTIMATING GLUTEN IN FLOUR.

By LESTER REED, A.I.C.

HAVING some time ago had occasion to seek a rapid approximate method of estimating the quantity of gluten in flour, I found the following to give fairly correct results with known mixtures of white flour and starch (arrowroot being the form of starch employed in the experiments):—

The principle upon which the estimation is based is the production of a yellow nitro-body when nitric acid acts upon albumenoids. 0.5 of a grm. of flour is weighed out and carefully transferred to a test-tube, which is divided (beginning at the bottom and ending the graduation about half way up) into four parts of equal capacity; water is now to be added up to the fourth mark exactly, and the test-tube violently shaken, being closed by the cushion of the thumb. Frothing is best avoided if the shaking be terminated by successive inversions of the tube; the contents are temporarily transferred to another dry test-tube whilst the marked one is cleaned (all the pourings out are to be done immediately after shaking). A quarter of the liquid is now poured back, viz., up to mark 1, and the tubes filled up to mark 3 with nitric acid of strength such that half a test-tube full of it appears white, when a white surface is observed vertically through it, but the acid should, barring this condition, be as strong as possible.

The test-tube is now to stand exactly five minutes, with occasional shaking up, and is then to be filtered immediately after shaking through a dry filter into a dry receptacle; a standard flour is to be treated in the same way and the two clear yellow solutions examined colorimetrically; the qualities of the flours are then inversely as the heights of equal colour.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY
SAMPLES OF THE WATER SUPPLIED TO LONDON, FOR
THE MONTH ENDING JUNE 30TH, 1883.

By WILLIAM CROOKES, F.R.S.

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and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London
Hospital; Medical Officer of Health for Islington.

London, July 5th, 1883.

SIR,—We desire to submit, for the information of the Local Government Board, a statement of the particular and general results of our examination, made at the expense of the Water Companies, of 182 samples of water, collected by us within the past month at the times and places indicated, from the mains of the seven London companies taking their supply from the Thames and the Lea; together with some remarks on the character of the supply during preceding months.

We are, Sir,

Your obedient Servants,

WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

To the Secretary of the Local Government Board.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from June 1st to June 30th inclusive. The purity of the water, in respect of organic matter, has been determined by the Oxygen and the Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples submitted for analysis.

Of the 182 samples of water submitted to examination, the whole without exception were clear, bright, and well filtered. In respect to aëration, and to freedom from colour and excess of organic matter, they have maintained the excellent character exhibited for some months past.

In our previous brief report for the month of May we stated that "of the 182 samples of water submitted to examination (including 26 samples of the Southwark Company's water), the whole, without exception, were clear, bright, and well filtered." The Report of the official Water Examiner on the state of the Southwark Company's water during May is as follows:—"Daily samples were taken at the works, and the water found to be clear, bright, and efficiently filtered." But in the Report to the Registrar-General for May it is written, "With the exception of the sample of the Southwark Company's supply, which was very slightly turbid, and contained moving organisms, all the water was efficiently filtered"—as usual, no information being vouchsafed as to the names and nature of these same "moving organisms." This one

sample of the Southwark water, suggested as typical of the Company's supply during the month, was drawn on May 29th, at the cab-stand near Kennington Church. Our own sample of Southwark water for the same day was taken at St. George's Church, Borough. We have, since the publication of the Report to the Registrar-General, examined afresh a reserved duplicate sample of this water, and again found it to be clear, bright, well-filtered, and free from "moving organisms," whether animal or vegetable.

In the same Report to the Registrar-General it is stated that the Thames-derived water sent out by the Companies during May "was, *for river water*, unusually free from organic matter, though not so much so as in the previous month,"—the river water thus condemned by insinuation, as queer stuff at the best, being the particular water authorised to be taken for the supply of London; and that, after full enquiry by Parliamentary and Royal Commissions, and with a full knowledge as to the fact of organic matter in a variable proportion, being one of its characteristic constituents. Elsewhere, in the same Report, this characteristic constituent of river water is spoken of as "organic impurity;" and the Thames-derived waters, even of the "unusually" good character exhibited during the month, are stigmatised as containing from 2 to $3\frac{1}{2}$ times as much "organic impurity" as another variety of metropolitan water, which being derived from deep wells, is comparatively free from a constituent, however unobjectionable, that is more especially characteristic of water from rivers and lakes. As usual, it was not thought advisable to point out that, measured by the same ingeniously contrived standard, the "organic impurity" of the Glasgow Corporation's far-famed Loch Katrine water was found to be in excess of that contained in the Chelsea, Grand Junction, and New River Companies' waters.

It is interesting to note the actual quantities of organic matter met with in the river-derived water supplied to London during the past six months. The mean amount of organic carbon, as deduced from our 156 determinations, comes to 0.175 part in 100,000 parts of water. The Report to the Registrar-General for June is not yet published, but the mean results of the 30 determinations made up to May, namely, 0.183 part in 100,000 parts of water, is identical with the mean result of our 130 determinations made up to the same period. These mean amounts of organic carbon, or 0.175 for the six months and 0.183 for the five months, correspond respectively to about 0.30 and 0.32 of a grain of organic matter per gallon of water. In four samples only, out of the 156 samples examined, was the organic matter found to exceed, and that by very little, half-a-grain per gallon, a proportion falling considerably short of the thousandth part of one per cent. of the water.

During the months of January and February the river was in a state of flood, and the proportion of organic carbon, and consequently of organic matter, though scarcely exceeding the proportion usually present at this season of the year, was somewhat high. A decided diminution, however, became observable in March, and has continued ever since. The middle line of the following table sets forth the average amounts of organic carbon per 100,000 parts of water, present in the entire river-derived supplies distributed during each of the first six months of the year. The upper and lower lines give the corresponding mean oxidation and colour-tint determinations, but on a special scale, different from the scales used in the monthly tables, and selected arbitrarily to show the relationships subsisting between the results of the three modes of examination. It will be observed that, despite some partial discrepancies, the parallelism is on the whole exceedingly close:—

Mean Temperature ..	41.3°	42.8°	35.5°	46.5°	53.3°	58.9°
	Jan.	Feb.	Mar.	April.	May.	June.
Oxygen from Per- manganate }	0.186	0.214	0.103	0.093	0.117	0.127
Organic Carbon ..	0.221	0.230	0.150	0.114	0.139	0.132
Depth of Tint ..	0.175	0.246	0.110	0.100	0.136	0.113

FIXATION OF INDIGO UPON COTTON.

By MM. SCHLIEPER and BAUM.

GRIND up for two days—

Indigo	25 kilos.
Water	100 litres
Caustic soda, sp. gr. 1.35	50 "
Dry caustic soda	58.53 kilos.

Care must be taken that the temperature does not rise too much during the solution of the soda, not exceeding, 40° C. This mixture keeps well and gives a better result when it has been prepared for some time.

For the printing colour there is mixed for a dark shade—

British gum	3 kilos.
Maize starch	1.50 "
Water	3.75 "
Caustic soda, at 1.35	16.00 "
The above mixture	30.00 "

54.00 kilos.

Containing 55.5 grms. indigo per kilo. For medium and light blues, the thickening and the water remain the same, but the soda-lye is increased respectively to 28 and 40 kilos., and the indigo mixture decreased to 18 and 6 kilos., so that in the complete colour there may be 33.3 grms. and 11.1 grm. of indigo per kilo.

The British gum is maize starch only two-thirds roasted. It is essential to make use of a good thickening. According to the numerous trials of the authors maize starch is the best for this colour on account of the formation of "apparatine" which takes place under the influence of the soda-lye.

The British gum, starch and water, are mixed till completely uniform, and the soda-lye is then added by degrees, at first by half litres and then by a litre at a time, stirring well.

This operation takes an hour; at the end of this time the indigo-preparation is added and the mixture heated to 55° in the water-bath, stirring well, and then cooled immediately. The colour may be used the next day if it has taken a galatinous consistence. It must be gently heated if it has been exposed for a long time to cold or if it has not been used for months. The cloth is prepared with glucose at 7.5 to 8° B; $2\frac{1}{2}$ kilos. glucose to 10 litres water.

The following are the essential points for the use of this colour.

The cloth prepared with glucose should be well dried so that the glucose may retain the smallest possible quantity of water. The colour should be very thick and little pressure should be used in printing, so that the colour should lie on the surface of the cloth and not penetrate; in other words, there must be two layers upon the cloth, one of glucose and the other of the colour. After printing it must be dried very quickly, which is easy as the colour contains but little water; but not too strongly, lest a greenish shade should be produced; it is preferable to leave the pieces slightly moist. To authors dry with air at 60—70° and with Root blowers. The object is to prevent the colour from acting upon the colour after printing; the reduction of the indigo should only take place on steaming.

Immediately after printing the pieces pass for 10 to 15 seconds into a small steaming apparatus; this time is sufficient for the complete reduction of the indigo, and if the action were prolonged the indigo would be decomposed. The steaming apparatus must be as small as possible and is placed over a reservoir of boiling water. The steam should be exempt from oxygen; the action of the air which the piece brings with it is paralysed by the strong current of steam, continually renewed in this confined space. On leaving the steam the pieces pass for two minutes into a cistern fitted with rollers and supplied with a stream of cold water. Errors committed either in preparing, drying, or steaming may reduce the result very seriously.

The only good resist is precipitated sulphur, 140 grms. of which to a litre of thickening resist the heaviest shades.

Yellow resist:—

Cadmium chloride	200 grms.
Precipitated sulphur	140 „
Thickening	1 litre

*Red resist:—*Red liquor, tin crystals, calcined starch, and 130 grms. precipitated sulphur. For nankeens and all ordinary colours use 130—140 grms. sulphur per litre.

Light Blue.—Upon cloth prepared with glucose there is printed caustic soda, at sp. gr. 1.35, thickened with British gum and maize starch; steamed for 15 seconds and padded with the indigo-colour. The glucose is destroyed in contact with the soda, the colour is only partially developed and gives a light blue. White, yellow, chamois, and light blue resists succeed easily, but for a red resist the cloth must be passed into sal-ammoniac if there is no appliance for quickly removing the soda. An indigo-colour may easily be discharged upon Turkey-reds and upon the mordant for Turkey-reds, thus producing very nice styles.

Mordant for Turkey-Reds.—We heat for three hours 40 kilos. gelatinous alumina with 64 litres caustic soda 35° B. and make up 300 litres with water. Neutralise with 8 litres hydrochloric acid at sp. gr. 1.150 and make up with water to 620 litres.

Mordant for Padding.—To 4 litres of the above mixture there is added 1 litre water. The padded cloth is dried on the drum, when it turns yellow, but resumes its original colour after ageing. The pieces are left in a heap till the morning and are then passed into cold water in a cistern fitted with rollers, well-washed, and taken through luke-warm chalk-water to convert the sodium bi- or tri-aluminate into calcium aluminate. When this mordant is ready for dyeing it can bear taking through sulphuric acid at 8° B. without losing much of its depth. It is the same with the reds dyed with this mordant. Upon this property is founded the production of indigo discharge styles.

Indigo Turkey-Red.—The cloth, mordanted for or dyed with alizarin, is saturated with glucose; the indigo colour is printed on, steamed, washed, exposed to the air for a few minutes, passed into sulphuric acid at 8° B. for 10 to 20 seconds, washed, passed into weak carbonate of soda and washed. The red pieces are soaped at a boil when the alizarin, which is under the indigo, is dissolved and the blue colour appears.

White on Turkey-red and Indigo Blue.—We print on the dark blue and a strong soda-lye and proceed as indicated. Or we print a strong lye upon the Turkey-red mordant, steam to destroy the glucose, dry, and print on the indigo.

—*Moniteur Scientifique.*

ON CERTAIN REAGENTS FOR VEGETABLE ALKALOIDS.

By R. PALM.

I. Sodium Sulphantimoniate or Schlippe's Salt.—Some years ago I called attention to the group of alkaloid sulphides, proving that the salts of the alkaloids are precipitated with a yellowish colour by solutions of alkaline sulphides and persulphides, and I have further demonstrated the existence of alkaloid double sulphides, which are formed when solutions of alkaloid salts come in contact with the solution of sodium sulphantimoniate. The characteristically-coloured precipitates thus produced consist of alkaloid sulphide + antimony sulphide.

On mixing very dilute solutions of the alkaloids, and of the reagent, both as neutral as possible, the precipitations appear at first colourless, or milky suspensions; on exposure to the air they turn more or less yellowish and in concentrated solutions they appear at once yellow, or in different shades up to a reddish-brown, and in saturated solutions there are formed resinous masses.

In dilute solutions the precipitation is more complete than in the more saturated. Gentle heat and the addition of strong alcohol promote the separation. An excess of sodium sulphantimoniate dissolves the first-formed yellow precipitate in most cases. The double sulphides are, with few exceptions, amorphous, and dilute acids extract the alkaloid from them but partially. The reactions are in general sensitive, but I have not yet succeeded in ascertaining either their limits or the chemical constitution of these double salts.

Antimony-quinine Sulphide.—In dilute, neutral solutions of quinine sulphate, the reagent produces merely a milky turbidity; in strong solutions there is formed at once a yellow flocculent precipitate which, on shaking, coagulates in resinous lumps and becomes gradually darker. On mixing together hot solutions there are formed at once resinous masses, which, when dry, fall to a fine yellow powder, like lead iodide. In a strong solution the precipitation is imperfect, since ammonia throws down quinine from the filtrate. In dilute solutions the precipitation is more complete.

Antimony-cinchonine Sulphide.—In a dilute solution of cinchonine sulphate the reagent gives at once a flocculent precipitate which coagulates neither on standing nor on the application of gentle heat. The precipitate is darker than that of quinine, almost of a leather colour, and it is more complete than that of quinine.

Antimony-quinidine Sulphide.—With quinidine sulphate the reagent behaves almost exactly as with quinine sulphate, but with this difference, that on shaking or on mixing warm solutions only a part of the deposit collects in resinous masses, the rest falling as yellow flocks. The entire precipitate when dry is of a deeper yellow than those of quinine and cinchonine, resembling an intense, dark chrome yellow. The precipitation is more complete than that of quinine sulphate.

Antimony-morphine Sulphide.—In a dilute solution of morphine chloride there is produced at once a yellowish flocculent deposit; in strong solutions the precipitate is darker, but less complete. The precipitate, when dry, has the colour of powdered gamboge.

Antimony-codeine Sulphide.—In the solution of codeine chloride the reagent gives immediately a flocky precipitate. In dilute solutions the precipitation is more complete than in the more concentrated. The colour of the deposit when dry is paler yellow than that of morphine, resembling in its tone that of quinidine.

Antimony-narcotine Sulphide.—In concentrated and in hot solutions the precipitates coagulate in resinous masses. The reaction is much more sensitive than in case of the two foregoing opium-alkaloids. The deposit when dry has the colour of precipitated and dried ferric hydroxide.

Antimony-strychnine Sulphide.—Even in very dilute solutions of strychnine nitrate the reagent occasions a flocculent precipitate, colourless at first, but gradually turning to a pale yellowish colour, on exposure to the air. In concentrated solutions there is formed at once a rich yellow, homogeneous flocculent precipitate, which even on prolonged standing does not coagulate. The reaction is more sensitive than with all other vegetable alkaloids, the strychnine being entirely thrown down. The colour of the deposit when dry is a fine, intense, deep golden-yellow. The precipitate is not soluble in an excess of the reagent.

Antimony-brucine Sulphide.—If the reagent is added in successive portions to a moderately concentrated solution of brucine nitrate three distinct precipitates can be plainly observed.

a, a reddish yellow, which collects in resinous masses; *b*, a light golden yellow flocculent deposit; and *c*, a colourless, flocculent deposit, which collects in crusts on the surface of the liquid.

On boiling the mixture of these three precipitates in water the greater portion dissolves, leaving an amorphous, deep-orange residue. From the filtrate there crystallises

out, in the course of ten minutes, a pale yellow double sulphide in fine acicular tufts.

The liquid filtered from these crystals is still bitter, and if placed in a refrigerating mixture there is deposited in the course of a few hours a pale yellow, crystalline powder which is also a double sulphide. Crystalline deposits form also at common temperatures in the liquid filtered from the precipitate without previous boiling with water.

Antimony-atropine Sulphide.—In a strong solution of atropine sulphate the reagent occasions at once a yellowish deposit, which coagulates on shaking or heating. The reaction is not very sensitive and the colour of the dried precipitate is a lighter yellow than that of morphine.

Antimony-bebeerine Sulphide.—The reagent produces in the solution of bebeerine chloride an immediate dark-coloured precipitate, which coagulates in strong and especially in hot solutions. The colour of the double sulphide when dry is a greyish brown. All the double sulphides above mentioned are very stable. That the alkaloid sulphides can form double combinations with other metallic sulphides which are soluble in alkaline sulphides can scarcely be doubted.

II. Lead Chloride as a Reagent for Vegetable Alkaloids.—For this purpose we may use a solution of lead chloride either in water or in sodium chloride, which dissolves more lead chloride than pure water. The solution in either case is prepared hot. The alkaloids must not be employed as sulphates, as the lead would be precipitated by the sulphuric acid. The acetates, nitrates, or chlorides may be used—the last mentioned by preference. Most of the vegetable alkaloids are precipitated by this reagent in a colourless, finely crystalline state. The reaction is less sensitive than that of sodium sulphantimoniate. The precipitates obtained consist of lead chloride and an alkaloid salt.

Quinine is thrown down in pulverulent crystals; cinchonine, morphine, and codeine in small, fine needles. Strychnine, when dry, forms an asbestos-like, felted mass, showing distinct crystalline forms. Brucine gives a fine crystalline powder. In many alkaloids the crystalline deposits appear only after prolonged standing.

III. Sodium Chloride as a Reagent for Bebeerine.—Sodium chloride shows a remarkable behaviour with bebeerine chloride, the alkaloid of the tree *Nectandra Rodia*. If a strong solution of sodium chloride is mixed with a solution of the alkaloid, the latter is completely re-precipitated and with its original dark colour. Even in very dilute solutions of the alkaloid the separation is complete. This process might be utilised for the industrial preparation of bebeerine.—*Zeitschrift für Analytische Chemie*.

FORMATION OF SULPHIDES BY COMPRESSION. CONSIDERATIONS THENCE DERIVED CONCERNING THE PROPERTIES OF THE ALLOTROPIC STATES OF PHOSPHORUS AND CARBON.

By M. W. SPRING.

THE author has previously shown the possibility of uniting the fragments of solid bodies by the sole action of pressure. He also established at the same time the possibility of forming chemical compounds by means of pressure. Thus he obtained cuprous sulphide by compressing a mixture of sulphur dust and copper; mercuric iodide, by compressing mercuric chloride with potassium iodide, &c. Finally, by compressing in the same manner mixtures of the filings of different metals, he formed alloys having for equal compositions the same melting-points as those obtained by fusion.

The last-mentioned facts certainly establish the possi-

bility of causing bodies to enter into chemical reaction by the mere agency of a mechanical energy. This result is closely linked with another obtained during the course of the same investigation: the polymerisation of certain simple bodies, e.g., sulphur, by the action of pressure. The author had drawn a general conclusion from his experiments, and had announced that matter takes, below a given temperature, a state corresponding to the volume which it is compelled to occupy.

He has since undertaken a methodical study of the chemical reactions accomplished by the action of pressure. He had already shown the possibility of forming metallic arsenides by compressing mixtures of arsenic and of the filings of different metals (*Bulletin d'Académie Royale de Belgique*, t. v., 1883), and he now communicates the results obtained by compressing mixtures of sulphur and of certain metals or non-metals. The results not merely confirm the author's former conclusions, but they throw a new light on the relations of organic and inorganic chemistry, and exhibit the so-called simple bodies as capable of assuming a peculiar constitution varying according to the conditions in which they are placed, and the actions to which they are submitted.

He used the metals in the state of fine filings intimately mixed with flowers of sulphur previously thoroughly washed. The mixtures were made in atomic proportions and were submitted to a preliminary pressure of 6500 atmospheres. They then assumed the state of a hard compact mass, showing, on examination with the microscope, that the reaction of the sulphur and the metal had taken place wherever the elements were in contact. The mass obtained was then reduced into fine powder and compressed again from twice to eight times.

1. Sulphur and Magnesium.—After six compressions there was obtained a grey mass with a feebly metallic surface-lustre. It dissolves in water at 50° to 60° with a slow escape of hydrogen sulphide, the liquid becoming of a golden yellow. A drop of hydrochloric acid occasions immediately a very strong escape of hydrogen sulphide, whilst free sulphur is deposited. Hence magnesium and sulphur combine under the action of pressure, forming magnesium sulphide and possibly a poly-sulphide.

2. Sulphur and Zinc.—Three compressions yield a block deceptively similar to native blende with metallic lustre. Dilute sulphuric acid dissolves the block slowly with an escape of hydrogen sulphide.

3. Sulphur and Iron.—After four compressions a block is obtained which the file scarcely touches. Dilute sulphuric acid dissolves it easily with continuous escape of hydrogen sulphide. If the product of compression is heated in a closed tube no luminous phenomenon is observed, the body entering into tranquil fusion. Hence the potential heat of the free sulphur and iron has been realised during the compression.

4. Sulphur and Cadmium.—Three compressions give a yellowish grey homogeneous mass. The powder is yellow, but less pure than that of cadmium sulphide obtained by precipitation. Strong hydrochloric acid dissolves the mass with escape of hydrogen sulphide.

5. Sulphur and Aluminium.—Result incomplete. After five compressions a mass is obtained which, in contact with moist air, gives off an odour of hydrogen polysulphide.

6. Sulphur and Bismuth.—The combination takes place with great ease.

7. Sulphur and Lead.—The combination is still more easy.

8. Sulphur and Silver.—The action is slow; eight compressions are necessary.

9. Sulphur and Copper.—Three compressions complete the combination. When the product of the compression is heated there is no development of heat or light.

10. Sulphur and Tin.—Three compressions give a block which yields a yellowish grey powder, easily soluble in a hot solution of sodium sulphide. Stannic sulphide is therefore formed by the compression of sulphur and tin.

11. Sulphur and Antimony.—After two compressions

we obtain a grey-black mass having the colour and lustre of stibine. When powdered it dissolves with ease in hot hydrochloric acid, giving off hydrogen sulphide.

12. Sulphur and Red Phosphorus; Sulphur and Carbon.—Result entirely *nil*; there is produced not the least trace of phosphorus sulphide nor of carbon sulphide.

Conclusions to be drawn from these Facts.

The negative results just mentioned have an especial interest. It is established that red phosphorus has a higher specific gravity than white phosphorus, that of the former being 1.96, and that of the latter 1.82. The author's former researches (*Bulletins de l'Académie Royale de Belgique*, 49, p. 323, 1880) have shown that if sufficient pressure is applied to a body capable of assuming several allotropic states, it takes under pressure the state corresponding to its greatest density. It is consequently impossible to transform red phosphorus into white phosphorus by pressure. But we know, on the other hand, that sulphur and red phosphorus may be mixed with impunity at common temperatures without combination ensuing; to produce combination the temperature must be raised to about 260°, the point of transformation of red phosphorus into white phosphorus.

It is thus established that red phosphorus must first be changed from its allotropic condition before entering into combination with sulphur. The pressure opposing this change renders also the act of combination impossible; red phosphorus appears to us like a body which has lost its chemical faculties.

Thus, the combination of an element with itself, *i.e.*, its polymerisation, has really the effect of extinguishing its energy, rendering it incapable of fulfilling certain functions. The chemistry of red phosphorus, more simple than that of white phosphorus, may be considered as the chemistry of a deadened body. The phosphorus which is found in combination with sulphur in phosphorus sulphides, and that which enters into combinations of other kinds, is certainly not phosphorus in the red state; it is even possible, if not probable, that it is not even white phosphorus, but a substance still unknown in the free state.

We arrive at a similar but more complete conclusion as to the nature of carbon. It is known that the affinity of carbon for sulphur and even for oxygen only becomes manifest at a temperature bordering upon redness. Is not this tantamount to saying that in order to enter into combination with another body, carbon, like red phosphorus, must first change its allotropic condition. This view is supported by the following considerations:—The specific heat of amorphous carbon, and, *a fortiori*, that of graphite and diamond, form exceptions to the law of Dulong and Petit; they are too small by more than one-half. They would be normal if the atomic weight of carbon were greater than it really is; in other words if free carbon were a polymer of combined carbon. Rose has found that at a temperature of about 500° the specific heat of carbon agrees with the law of Dulong and Petit. At this temperature carbon undergoes a beginning of depolymerisation, *i.e.*, its chemical affinities reappear, and it burns readily in oxygen. Do not these facts show a complete parallelism between the chemical history of phosphorus and that of carbon?

Crystalline carbon, and even free amorphous carbon, are without chemical activity at the ordinary temperature; but when, in consequence of a rise of temperature, they take another state, they are transformed into a new kind of carbon, constituting a fourth allotropic state, and endowed with a prodigious capacity of combination. If these conclusions are well founded, we may venture a step further and ask if the carbon which enters into the composition not of mere *organic* compounds but of organised bodies, is not a carbon of still another allotropic state, characterised by the appearance of new properties or forms of combination which find their expression in the vital phenomena

In other words, a derivative of carbon, before forming part of a living body, must first undergo in its atoms a transformation similar to that which permits amorphous carbon to enter into the composition of organic compounds. In this order of ideas the carbon of organic chemistry would be merely a first deadened form of the carbon of biological chemistry, whilst free carbon is merely the defunct remains of the carbon of organic chemistry.—*Bulletin de la Société Chimique de Paris.*

PAPERS UPON INDUSTRIAL CHEMISTRY.

By Prof. ALBERT R. LEEDS.

THE ANALYSIS OF SOAP.

(Concluded from page 52.)

Method III. (Cairn's "Manual of Qualitative Analysis," page 244, somewhat modified.)

Water.—Dissolve 1 to 2 grms. in the smallest possible amount of strong alcohol, pour the solution upon sand in a dish, the sum of whose weight and that of the sand has already been determined, and dry in air-bath at 110° C., to constant weight.

[The objections to this method are that the weight taken is so small that it may not represent a fair average. It is difficult to transfer a strong alcoholic solution without considerable washing, and so increasing the volume of the alcohol to be evaporated. Great care is requisite in evaporating the solution not to lose by spiriting, even when the evaporation is conducted on a water-bath heated with a very small flame. The sand as well as the soap is hygroscopic, and even if, after ignition, the sand is allowed to cool to 110° in an air-bath before being transferred to a desiccator previous to weighing, the results are not accurate. It is not unusual to state as part of a soap analysis "water by difference," but in this case the direct determination of the water should be given also.—L.]

Solution.—Dissolve 5 grms. of the soap in 100 c.c. of 90 p.c. alcohol by warming on water-bath to 40° to 50° C.—Filter through a weighed filter-paper.—(A.) Filtrate. (B.) Residue on filter.

(A.) Filtrate. Precipitate the uncombined alkali as bicarbonate (NaHCO_3) by passing a slow stream of well-washed carbonic acid through the filtrate. Allow the well-covered beaker glass to stand until the liquid is clear, warm on the water-bath, filter, and wash with warm alcohol. Dissolve the precipitate in water, titrate with normal sulphuric acid, and calculate to NaHO for *uncombined alkali*.

Combined Fatty Acids.—Transfer the filtrate or the alcoholic solution in which CO_2 failed to produce a precipitate to a flask, add 100 c.c. water, and evaporate, or preferably distil off the alcohol. Add 15 c.c. of normal sulphuric acid and 5 grms. pure white wax, boil, filter through a wetted filter, and wash with boiling water until the washings are no longer acid. After pressing and drying between filter-papers, the weight of the cake, less the weight of wax added, is the sum of the weights of the combined fatty acids, uncombined fat, and resin.

[I failed in attempting to carry out these directions. The soap and wax were almost entirely in one large cake, but some was left after boiling on the sides of the beaker, and could not be removed by mechanical means. The use of solvents was likewise attended with difficulties and objections. By heating at 100°, however, until every trace of water was driven off and the weight became constant, and deducting the weight of the beaker, a result was obtained nearly identical with that found by Method IV.—L.]

Combined Alkali.—Titrate by normal soda solution the filtrate from the wax in order to find how much of the sulphuric acid has been neutralised by the combined alkali of the soap. Calculate to Na_2O .

(B.) *Residue*.—Wash the residue on filter with hot alcohol, dry at 110° , and weigh. Wash with water, dry at 110° , and weigh. The last weighing gives the *insoluble residue*. The wash water which contains the free carbonate is titrated with sulphuric acid, and the result calculated to Na_2CO_3 .

Uncombined Fat.—Treat 5 grms. of the soap (cut into very fine shavings) with ether two or three times, pouring off the ether into a weighed dish. The operation may be assisted by placing the vessel over a water-bath containing hot water, but with no flame under it. Since the ether may dissolve small portions of the soap, it is safer to evaporate off the ether from the first extraction, and then to treat the residue again with ether. The weight of the residue left on the last evaporation of the ether gives (2) uncombined fat. Carbon disulphide may be used in place of ether.

[Complete and satisfactory extraction with ether is troublesome to effect in an open dish.—L.]

Resin.—Dissolve 40 grms. of the soap in boiling water, add an excess of sulphuric acid to separate the fatty acids and resin; cool, pour off the aqueous portion, and digest the fatty residue with equal volumes of alcohol and water, agitating from time to time. Pour off the milky fluid, add more alcohol and water, and digest again. Repeat this until the fluid ceases to become milky, then add water and a weighed quantity of wax as before, filter, dry, and weigh the cake. The weight represents that of the fatty acids deprived of the resin. The difference of percentage obtained in this way from the percentage obtained as above described gives approximately the amount of the resin present.

[This method is very difficult of execution, and gives only approximate results.—L.]

Glycerin.—Dissolve 5 grms. of the soap in 90 per cent alcohol, add dilute alcoholic sulphuric acid (1 vol. sulphuric acid to 10 vols. alcohol) so long as a precipitate forms, wash with alcohol, digest with barium carbonate and alcohol until the alcohol is gone, filter, evaporate the filtrate to dryness in a weighed dish, and weigh the residue of glycerin.

[This residue should be entirely soluble in water, and should be carefully tested to see whether, as is probably not the case, it is pure glycerin.—L.]

Mineral Constituents.—Calcine 5 grms., dissolve in water, filter, wash, dry at 110° , and weigh the *insoluble residue*. Dilute to 100 c.c. In 25 c.c. determine *total alkali* by titration with half-normal sulphuric acid. In another 25 c.c. determine *chloride* by titration with standard silver nitrate, using potassium chromate as indicator. In a third 25 c.c. determine *sulphate* with barium chloride. In the last 25 c.c. determine *silicic acid* by evaporation to dryness with hydrochloric acid.

[This makes the sixth separate weighing of different portions of the sample, and contemplates the determination of two previously-determined constituents. By ignition with so much organic matter any sulphate present is partly reduced to sulphide.—L.]

Method IV. (By Julius Loewe, Fresenius's *Zeitschrift* xix., p. 112.)

Water.—8 to 10 grms. of the soap in fine shavings is heated first at 60° to 70° , then at 100° to 105° to constant weight. In order to prevent absorption of CO_2 by the free alkali, the desiccation should be performed in an atmosphere free from CO_2 .

Uncombined Fat.—The thoroughly dried soap which has been used in the water determination is treated two or three times with warm benzol or petroleum ether in a tall covered beaker. After each treatment the liquid is allowed to stand until clear, and decanted into a tared flask. If the liquid cannot be safely decanted it is filtered through a weighed filter, which is afterward employed for the alcoholic solution of the soap. The filtrates are finally distilled, and the weight of the residue in the flask, after drying at 110° , gives the uncombined fat

The residue from the uncombined fat is treated with eight to ten times its weight of 90 p.c. alcohol, and warmed on water-bath to 40° to 50° . The fatty acids along with the caustic alkali and glycerin are dissolved, while soda carbonate, potato starch, and mineral matters remain undissolved, and after washing with hot alcohol and drying at 100° , are weighed. In the better soaps for household use, only a residue of 1 to 1.5 per cent at the highest, and consisting mostly of soda carbonate, should remain.

Examination of this Residue: Starch Meal and Mineral Constituents.—Wash with cold water until the filtrate amounts to exactly 60 c.c. Wash the filter, and precipitate with alcohol until it has taken the place of the alcohol, dry at 100° , and weigh. The weight gives the amount of insoluble organic matters, like starch, &c. (which should be further examined under the microscope), and insoluble mineral matters.

In 15 c.c. of the 60 c.c. filtrate determine the quantity of carbonic acid set free by acid, and calculate therefrom the quantity of soda carbonate.

[This method of estimation is less convenient than that by titration, as before given, and no more accurate.—L.]

In another 15 c.c. determine the chloride, and in another the silicate.

Uncombined Alkali.—The filtrate from the above residue is treated with CO_2 , the beaker well covered is allowed to stand on a water-bath until the supernatant liquid has become clear, and the precipitate of carbonate is filtered and washed with warm alcohol.

Combined Alkali.—The alcoholic filtrate is treated with alcoholic sulphuric acid (1 : 10) as long as precipitation occurs; after standing, the precipitated sodium sulphate is filtered off, collected on a weighed filter, washed with alcohol, dried at 110° , and weighed. From this weight is calculated that of the combined alkali.

Combined Fatty Acids.—To the filtrate acidified with sulphuric acid water is added in a platinum dish, and the alcohol expelled by heating. After cooling, the fatty acids are separated by filtration.

Glycerin.—The filtrate is treated with barium carbonate to remove the excess of sulphuric acid, and contains the glycerin.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Professor of Chemistry and Physics in the University of Cincinnati.

SILVER, POTASSIUM, SODIUM, CHLORINE, BROMINE, IODINE, AND SULPHUR.

(Concluded from p. 54).

WE are now in a position to determine more closely the molecular weights of the haloid salts which we have already been considering.

For silver chloride, still employing the formula for the probable error of the last term of a proportion, we get the following values:—

From (5)	AgCl =	143.062	± 0.032
From (13) and (F) ..	"	143.032	0.014
From (17) and (21) ..	"	143.108	0.034
From (18) and (26) ..	"	143.061	0.041
From (19) and (27) ..	"	143.035	0.033

General mean.. .. " 143.045 ± 0.0108

Subtracting from this the atomic weight of silver, 107.675, ± 0.0096 , we get for the atomic weight of chlorine, $\text{Cl} = 35.370, \pm 0.014$.

* Smithsonian Miscellaneous Collections. "The Constants of Nature."

For silver bromide we have these results:—

From (6)	AgBr = 187'453 \pm 0'043
From (14) and (G) ..	" 187'440 0'018
From (18) and (25) ..	" 187'454 0'053
General mean	" = 187'443 \pm 0'016

Hence using the general mean for silver as above, Br = 79'768 \pm 0'019.

Silver iodide comes out as follows:—

From (7)	AgI = 234'195 \pm 0'053
From (15) and (H) ..	" 234'237 0'023
From (19) and (25) ..	" 234'240 0'054
General mean	" 234'232 \pm 0'019

Hence I = 126'557 \pm 0'022.

For the molecular weight of sodium chloride we have:—

From (4)	NaCl = 58'366 \pm 0'0137
From (9) and (E) ..	" 58'368 0'0056
General mean	" 58'3676 \pm 0'0052

Hence if chlorine = 35'370 \pm 0'014, then Na = 22'998 \pm 0'011.

For potassium chloride:—

From (1)	KCl = 74'4217 \pm 0'016
From (10) and (B) ..	" 74'4041 0'007
From (17) and (25) ..	" 74'3975 0'017
General mean	" 74'4057 \pm 0'0062

For potassium bromide we get:—

From (2)	KBr = 119'117 \pm 0'096
From (11) and (C) ..	" 118'810 0'0118
General mean	" 118'815 \pm 0'0117

And for potassium iodide:—

From (3)	KI = 165'210 \pm 0'053
From (12) and (D) ..	" 165'502 0'029
General mean	" 165'432 \pm 0'026

Now, taking the molecular weights of these three potassium salts in connection with the atomic weights just found for chlorine, bromine, and iodine, we get these values for potassium:—

From the chloride	K = 39'036 \pm 0'016
From the bromide	" 39'047 0'022
From the iodide	" 38'875 0'034
General mean	" 39'019 \pm 0'012

Finally the three sulphur ratios give us three estimates for the atomic weight of sulphur. In the third of these I have applied the "A" value for silver and the general mean for silver chloride:—

From (8) and (I)	S = 31'968 \pm 0'014
From (16) and (I)	" 31'995 0'032
From (20)	" 32'041 0'028
General mean	" 31'984 \pm 0'012

We may now appropriately compare the results of this discussion with the atomic weights deduced by Stas from his own experiments only. His values are given under two headings:— one for oxygen = 16, the other for O = 15'96. As we have been using the figure 15'9633 for oxygen, here is at the outset a discrepancy. Starting from this value we found:—

Ag = 107'675 \pm 0'0096
Cl = 35'370 0'014
Br = 79'768 0'019
I = 126'557 0'022
Na = 22'998 0'011
K = 39'019 0'012
S = 31'984 0'012

If we assume 16 to be the true figure for oxygen, we get the following results, which I have placed in a column parallel with the values found by Stas:—

	The New Values.	Stas.	Differences.
Silver ..	107'923	107'930	0'007
Chlorine ..	35'451	35'457	0'006
Bromine ..	79'951	79'952	0'001
Iodine ..	126'848	126'850	0'002
Sodium ..	23'051	23'043	0'009
Potassium ..	39'109	39'137	0'028
Sulphur ..	32'058	32'074	0'016

These differences are insignificant. No other criticism could more severely test the character of Stas' work, or more definitely illustrate his magnificent accuracy of manipulation.

NOTICES OF BOOKS.

The "A B C" of Modern Photography: comprising Practical Instructions in Working Gelatine Dry Plates. By W. K. BURTON, C.E. London: Piper and Carter. 1883.

THIS little manual is intended to fill a small gap in photographic literature on the working of dry gelatine plates, pre-supposing that the beginner possesses no knowledge of photographic operations. To suit the purposes of those amateurs who are artistically inclined but are deficient in scientific acquirements and manipulative skill, the subject is treated in a purely technical manner, all theory being carefully ignored. The instructions that are given for the working of this beautiful process are concise and clear, written in a style eminently suited to meet the requirements of non-scientific individuals. The first few chapters are devoted to the selection of the most economical apparatus to suit a beginner, the preparation of the chemicals required, and the arrangement of the "dark" room. Having got his appliances into working order, the art aspirant is at once started on his first experiment of exposing a plate, and the instructions given in order to secure success in this fickle operation are as clear as could be expected: with these before him, supplemented with a little experience, any tyro ought in a very short time to conquer some of the difficulties connected with this operation.

The chapter on lenses, we think, might have been extended, even at the expense of a little of the theory of optics, and the drawings that are given lettered, as well as the various parts of this, the most important instrument of the photographer, described. As addition to this matter, a separate chapter is given, with tables to facilitate judgment of exposure for different lenses. The defects peculiar to the gelatin dry-plate process and their remedy are fully explained, and finally the necessary operations for obtaining a "positive" are given in detail.

That this little book has in but a few months reached a third edition proves clearly its usefulness as a guide to dry-plate photography, and we think that any beginner following carefully the rules here laid down ought in a very short time to succeed in turning out a fair picture, or even in "perpetrating a portrait."

A Treatise on Electricity and Magnetism. By E. MASCART and J. JOUBERT. Translated by E. ATKINSON, Ph.D. Volume I. London: Thos. De la Rue and Co. 1883

THE English student of electrical science must be considered remarkably fortunate in having expressed in his

own language many of the most brilliant ideas that have yet emanated from the human intellect bearing upon this subject, as well as the development and concise mathematical statement of these ideas. The great influence that Faraday's method of conceiving electrical phenomena, as expounded in his *Researches*, has exercised over scientific men since his time cannot be over-estimated, and although his ideas were expressed in lengthy sentences, but none the less clear, it was left for the able mathematicians who succeeded him to show that his conceptions were of a strictly mathematical order, and capable of being symbolised and developed by the ordinary mathematical operations, by so doing basing the science on the surest of all foundations. Clerk Maxwell's great work on the science may be said to mark the beginning of a new era in the history of the advance of electricity, and by the translation of Faraday's ideas regarding lines of force and the part played by the medium in which electrical and magnetic actions take place into mathematical symbols, he did much to elucidate many of the phenomena and to annihilate empty space. Since the publication of this work, ten years ago, numerous treatises on this branch of science have been produced, and in each and all of these may be seen how much the various writers have been indebted to Maxwell, and the great influence his book has exercised over the conceptions and treatment of electrical phenomena.

The addition to the literature of electricity now before us, which is based upon a course of lectures delivered by one of the joint authors at the College de France, judging by the first part, gives promise of being one of no little value to the mathematical physicist by the clear and concise manner in which this difficult subject is handled. The style of the work is explained by the authors expressing the idea which has guided them by considering it as an essay on the mechanical theory of electricity. The present volume is divided into four parts, in which Statical Electricity, Electrical Currents, Magnetism, and Electro-Magnetism are respectively discussed from a mathematical point of view, many of the demonstrations of the theorems being remarkable for their neatness and simplicity, without detracting from their generality; but to digest all the matter that is here brought together would require a much greater depth of mathematical reading than is to be found amongst the average students of physics.

The characteristic feature of the book is the excellent plan of introducing many particular cases as problems, and effecting their solution by the principles developed, in which way only a student can ever hope to obtain a firm grasp of a mathematical subject. By so doing the difficulties in the way of reading Maxwell's work, owing to its generality, are rendered less perplexing, and the student learns the true meaning of the symbols with which he works.

The properties of fluids are invariably introduced by writers on electricity by way of analogy, with advantage, to facilitate the conception of many of the ideas, but it does not seem reasonable to designate by "flow of force" what Faraday called "number of lines of force," as is here done, or to speak of the "mass of electricity" for charge or quantity, or of the "emission and absorption of force by electrical masses."

No special chapter is given to spherical harmonics, although the analyses are occasionally introduced. This might have been of use to the student, also for the benefit of those who have not read Fourier's mathematical "poem," a short outline of the method by which the equations connected with the flow of electricity along wires are solved. Considering the mass of symbols that are employed in this treatise, so far as we see it, it is wonderfully free from errors. On page 17 occurs r for r' ; Laplace's equation is written on page 37 with x instead of z ; and in the value of the definite integral on page 218 a 2 is dropped.

Should the second volume promised, which is to be more of an experimental character, be of the same standard of excellency as the present one, the literature of electricity will have obtained a highly valuable contribution, and the

student of the science will have a complete, clear, and deep text-book from which to acquire a thorough knowledge of electricity.

Calculations of Densities and Expansions. By H. J. CHANEY. London: George E. B. Eyre and Wm. Spottiswoode. 1883.

THE contents of this small pamphlet, issued by the Standards Office, Board of Trade, consist of a number of valuable formulæ and tables relating to the corrections necessary to be made for change of pressure and temperature in the weight of air and of water in determining the true weight and density of solid bodies. The pamphlet is divided into four sections, the first three being on the weight of air, the expansion of water, and the expansion of solid bodies respectively, and contain the formulæ employed in applying the corrections for temperature and pressure, with examples illustrative of their use, the fourth section giving the numerics relating to these formulæ. In some of the tables that are here given, the data on which they were based when they were originally drawn up in 1856 have been re-examined, and although a few alterations have been made in the data the new tables do not differ appreciably from those contained in the papers of Prof. W. H. Miller and Sir G. B. Airy, to be found in the *Philosophical Transactions* for that year.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvii., No. 4, July 23, 1883.

Historical Part Played by the Invention of Artificial Soda obtained from Common Salt.—M. Dumas.—An eloquent survey of the industrial consequences of this invention delivered in connection with the proposal of the municipality of Issoudun to erect a monument in honour of Nicholas Leblanc.

Origin of the Combined Nitrogen existing on the Surface of the Earth.—A. Müntz and E. Aubin.—The authors show that the only noteworthy agent for the production of nitric or nitrous acid from the free nitrogen of the atmosphere is the electric discharge. They consider that unless the supply of the oxides of nitrogen thus generated is greater in tropical regions than it has been found to be in Europe it will be difficult to explain, by electricity alone, the compensation of the nitrogen which is incessantly wasted, and especially the accumulation of combined nitrogen which exists on the surface of the globe. Hence another cause must be sought for the production of nitrogenous compounds. It has been proved by the experiments of M. Boussingault upon plants, and those of M. Schloesing upon the soil, that neither of these is able to assimilate free nitrogen. Hence the authors are inclined to seek the source of combined nitrogen in the violent combustions which must have ensued at a certain stage of the earth's existence, when the elements which had been dissociated by an elevated temperature re-combined in presence of oxygen and nitrogen, involving the formation of nitrous compounds. It is known, indeed, that large quantities of nitrous acid are formed whenever any body is burnt in air. According to the authors' experiments, 1 grm. of hydrogen burning in air yields as much as 0.001 grm. nitric acid, whilst 1 grm. yielded as much as 0.100 grm. Hence, at the first appearance of organic beings upon the earth, there existed a large stock of nitrogenous compounds in the air and the soil upon which we are still subsisting, and which is decreasing

under the influence of the causes which effect the escape of free nitrogen unless the supply is kept up by the action of atmospheric electricity.

A Universal Galvanometer Free from Oscillation for the Rapid Measurement of Currents of Great Intensity and of High Tension.—M. Ducretet.—This instrument cannot be intelligibly described without the accompanying figure.

Formation-Heat of the Potassium Fluorides.—M. Guntz.—The author gives the formation-heat of the anhydrous fluoride, of the crystalline salt with 4 mols. of water, and of fluo-potassium hydrofluoride.

Nitro-derivatives of Ethylene Hydride.—A. Villiers.—The author continues the study of a compound of tetra-nitro-ethylene bromide and of potassa, described *Comptes Rendus*, xciv., p. 1122. He also examines the action of nitric acid upon bromised ethylene bromide.

Certain Derivatives of Mannitic Hexylene.—L. Henry.—The author has obtained and examined hexylenic mono-chlor-hydrine, mono-brom-hydrine, mono-iod-hydrine, aceto-chlor-hydrine, chloro-nitrite, dinitrite, hexylene bichloride and monochloride, and hexylenic acetone.

Products derived from the Bacterial Fermentation of the Albumenoids.—Arm. Gautier and A. Etard.—In a former communication (*Comptes Rendus*, xciv., pp. 1357 and 1598) the authors have described the products obtained by the splitting up of the albumenoids under the action of putrid ferments. They now show that whatever may be the albumenoid matter which is putrefying and up to a certain point, the variety of the putrid ferment, the principal ptomaines—as obtained from the flesh of mammalia, of fishes and mollusca, and from the white of eggs, &c.—are constant in properties and in composition.

Alleged Transformation of Brucine into Strychnine.—M. Hanriot.—Sonnenschein announced (*Berichte Deutsch. Chem. Gesell.*, viii., p. 212) that on gently heating brucine with dilute nitric acid, carbonic acid escaped, while there remained behind a solution containing a yellowish resin (the cacotheline of Laurent, Gerhardt, and Hofmann) and strychnine. The author, on experimenting according to Sonnenschein's directions, but with perfectly pure brucine, did not obtain a trace of strychnine. Hence he ascribes Sonnenschein's result to the use of an impure brucine. If brucine is mixed with even one-half of strychnine, the latter cannot be detected by its ordinary reaction. Brucine thus, like morphine, quinine, methylic alcohol, &c., masks the reaction of strychnine. As regards the physiological action of brucine, the question arises whether the samples experimented with were really pure?

Combustion-heat of Coal.—M. Scheurer-Kestner.—The author defends the results obtained by M. Meunier-Dollfus and himself (*Comptes Rendus*, lxxvi., p. 1047) against the criticisms of MM. Bunte and Stohmann, who consider the figures of M. Scheurer-Kestner too high.

Bulletin de la Société Chimique de Paris.
No. 1, July 5, 1883.

Transformation of Glycolide into Glycolic Acid.—M. de Forcrand.—The author determines the sign and the quantity of the heat produced in this transformation.

Russian Chemical Society.—Session January 6/18, 1883.—M. Beketoff has examined if the displacement of a metal by another metal in the moist way has a limit. He finds that at ordinary temperatures it is effected on the principle of maximum work.

MM. Alexeef and Kissel communicated the conclusion of their researches on azo-cuminic acid.

M. Kissel sent in a study on the action of the alkalies in presence of nascent hydrogen upon nitrethane and secondary nitro-propane.

M. Bogdanoff gave an analysis of the clays of Kiew.

M. Tchirikoff presented an apparatus for demonstrating the combustion of ammonia.

M. Kondakoff gave analyses of the refractory sulphuretted clays of Bachinot.

M. Koukline has studied the specific-heat and the evaporation-heat of certain of the products obtained by the fractionated distillation of petroleum.

M. Gustavson explained his researches on the action of aluminium bromide upon the bromides of the alcohol radicles and upon ethylene in presence of hydrobromic acid.

M. Gawriloff communicated a note on the composition of the humus of soil taken in the Government of Tula.

M. Gustavson gave an opinion on the mode of combination of iron and aluminium phosphates with humus.

M. Krustchoff sent a note on the solution-heat of saline mixtures.

M. Mendelejeff described a new apparatus for the determination of vapour-densities.

Biedermann's Central-Blatt für Agrikultur-Chemie,
Vol. xii., Part 5.

Seeds of Weeds existing in Arable Soils.—H. Putensen.—From the observations undertaken the number of such seeds existing in the soil is found to be almost incredibly great.

Manurial Experiments at the Kiel Agricultural Station.—Prof. A. Emmerling.—Ammonia had a slight action upon clay soil, the extra outlay having been fully compensated in two cases only. On sandy soils the results were very unfavourable. On black soil, rich in humus, the returns were good. Superphosphate proved more or less superior to precipitated phosphate. The action of dissolved Peruvian guano was better than that of the crude guano, both as regards grain and straw.

Cosmos les Mondes.
Tome v., No. 10, July 7, 1883.

This number contains no chemical matter.

No. 11, July 14, 1883.

Protective Coating for Glass.—M. Schaal proposes the following process for the protection of retorts and other apparatus of glass exposed to high temperatures. He makes a mixture of kieselguhr (infusorial earth) and of soluble sodium silicate. This mass is applied as a soft paste, but not too liquid, so as to form a coating of 5 to 10 m.m. in thickness. The articles are then dried slowly.

MISCELLANEOUS.

Fast Red or Rocellin.—"Aequum et Bonum" is in error by stating that the Expert appointed by the Court in Badische Aniline and Soda Fabrik *versus* Levinstein made three sulphonations of α -naphthylamine, viz., one with 80 per cent, one with 30 per cent, and one with 10 per cent of fuming anhydrous sulphuric acid. The fact is that, although the Plaintiffs alleged that Defendant infringed the third process of which the sulphonation of naphthylamine is an essential part, the Court instructed the Expert to endeavour to sulphonate oxy-azo-naphthalene, and the Report of the Expert has reference only to the sulphonation of oxy-azo-naphthalene, which sulphonation is described in the first process of the Patent. There is some other passage in "Aequum et Bonum's" statement which is not quite correct, but as this case is not yet finally disposed of, it may be preferable to abstain from further comments.

ST. PAUL'S SCHOOL.—An EXAMINATION for FILLING UP about TWENTY VACANCIES on the FOUNDATION will be held on the 4th September, 1883. For information apply to the Clerk to the Governors, Mercers, Hall, E.C.; or to the School Secretary, St. Paul's Churchyard, E.C.

THE LONDON HOSPITAL and MEDICAL COLLEGE, MILE END, E.—The SESSION 1883-4 will commence on Monday, October 1st, 1883, when the Prizes for the past Session will be distributed, after which there will be a Conversation, to which all past and present students are invited. **FOUR ENTRANCE SCHOLARSHIPS**, value £60, £40, £30, and £20, will be offered for competition at the end of September to new Students. Fees for Lectures and Hospital Practice, 90 guineas in one payment, or 100 guineas in three instalments. All resident and other Hospital appointments are free. The resident appointments consist of Five House Physiciancies, Five House Surgeoncies, and One Accoucheurship; Two Dressers and Two Maternity Pupils also reside in the Hospital. Special entries may be made for Medical and Surgical Practice. The London Hospital is now in direct communication by rail and tram with all parts of the metropolis.

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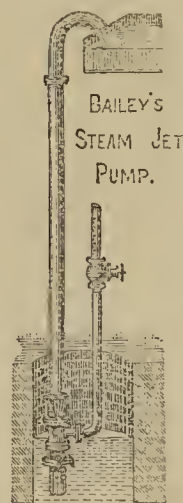
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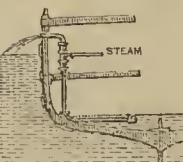


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THE CHEMICAL NEWS.

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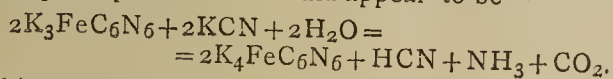
ON THE REDUCTION OF POTASSIUM FERRID-CYANIDE BY POTASSIUM CYANIDE.

By C. L. BLOXAM.

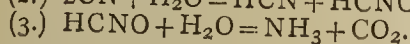
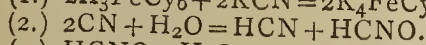
CRYSTALLISED KCN (containing but little K_2CO_3) was dissolved in water, the solution heated in a retort, and potassium ferridcyanide added. The green colour of the latter changed to yellow, and the distillate contained much hydrocyanic acid and ammonium carbonate, the latter increasing in quantity towards the end of the distillation.

A small quantity of the cyanide effected the reduction of a large quantity of the ferridcyanide. On cooling, the solution deposited abundant crystals of potassium ferrocyanide. The mother-liquor was nearly neutral when the reaction was complete, and contained only minute quantities of cyanate and formate of potassium.

The principal reaction would appear to be—



This may be represented as taking place in three stages:—



When some of the same sample of KCN was distilled with water alone much HCN was found in the distillate, and some NH_3 , but no CO_2 . The liquid in the retort, even after repeated distillation with water, contained much undecomposed cyanide, together with potassium hydrate, potassium carbonate, and a little formate.

King's College, London.

ON SOME REACTIONS OF THE CYANIDE, FERROCYANIDE, AND FERRIDCYANIDE OF SILVER.

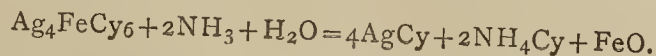
By C. L. BLOXAM.

It is stated in the Second Supplement of Watts's "Dictionary" (p. 414), on the authority of Weith, that silver ferrocyanide, when boiled with aqueous ammonia, is completely decomposed, yielding ferrous oxide, silver cyanide, and ammonium cyanide. On making the experiment, I found that metallic silver was deposited on the sides of the test-tube, which led me to examine the reaction. When the well-washed snow-white precipitate formed by silver nitrate with potassium ferrocyanide is shaken with moderately strong ammonia, it forms an opalescent liquid which passes through a filter. When heated, it becomes of a brownish grey colour, and deposits a thin film of dead silver on the sides of the tube.

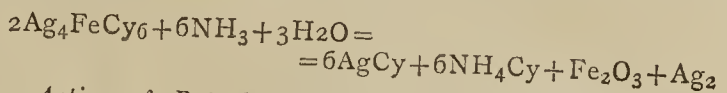
The grey precipitate was well washed, and a portion of it was treated with hot dilute nitric acid, which evolved nitrous fumes, and gave a solution containing silver nitrate and ferric nitrate, leaving a red residue of ferric oxide mixed with a little silver ferridcyanide.

Another portion of the grey precipitate was digested with ammonium sulphide, but no sulphocyanide was found, proving that no silver cyanide had remained undissolved by the ammonia. A third portion was treated with hydrochloric acid, which gave a solution containing both ferric and ferrous chlorides.

The ammoniacal filtrate, when neutralised with nitric acid, gave a copious precipitate of silver cyanide, and the filtrate from this contained much ammonium cyanide. It appears, therefore, that, in addition to the reaction given by Weith, viz.—

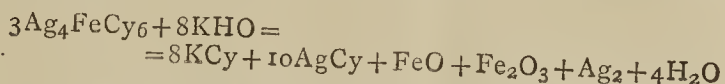


Another reaction occurs, probably represented by the equation—



Action of Potash on Silver Ferrocyanide.—A strong solution of potash, acting in the cold upon silver ferrocyanide converts it into a very heavy brown precipitate in a colourless supernatant liquid which deposits a little metallic silver when heated, and stains paper brown, apparently by the deposition of silver. It contains a trace of potassium cyanide, but no ferro- or ferridcyanide. The brown precipitate contained metallic silver mixed with silver ferridcyanide and ferrocyanide. A part of the silver ferrocyanide appears to be converted into ferridcyanide, with separation of silver, $2Ag_4FeCy_6 = 2Ag_3FeCy_6 + Ag_2$. The ferridcyanide thus formed, then enters into combination with the unchanged ferrocyanide, forming a compound which is not decomposed by cold potash, and does not yield its silver ferridcyanide to warm ammonia.

When boiled with potash, the silver ferrocyanide yields a solution containing silver cyanide and potassium cyanide and a black residue of ferrous and ferric oxides and silver; probably—



Action of Potash on Silver Ferridcyanide.—The well washed brown-red silver ferridcyanide precipitated by silver nitrate and potassium ferridcyanide, when treated with potash in the cold, became black, yielding silver oxide and potassium ferridcyanide which dissolved. On boiling, the black precipitate changed to a pink colour, and on continuing to boil this again became black.

The formation of the pink precipitate was attended by evolution of ammonia.

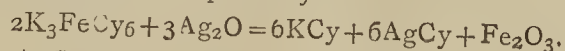
The pink precipitate contained a compound of silver cyanide with silver ferridcyanide, which was insoluble in ammonia, together with silver ferrocyanide, silver cyanide, and ferric oxide. The filtrate from the pink precipitate contained much potassium cyanide and silver ferrocyanide, with a little silver cyanide and potassium formate. The black precipitate finally obtained consisted of metallic silver and ferric oxide.

The filtrate from the black precipitate contained much potassium cyanide and silver ferrocyanide, together with silver cyanide and a little silver ferridcyanide.

As it seemed probable that the pink precipitate was a result of a reaction between the potassium ferridcyanide and the silver oxide formed in the cold, a quantity of well-washed precipitated silver oxide was boiled with solution of potassium ferridcyanide, when the same pink precipitate was produced, with evolution of ammonia.

On continuing the ebullition, the pink precipitate became black as before.

The first reaction is probably—

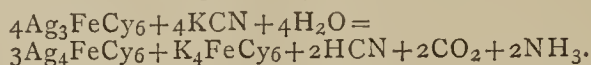


The $AgCy$ then combines with some of the undecomposed silver ferridcyanide to form a more stable compound.

It was found that when silver cyanide and silver ferridcyanide are dissolved in ammonia, and the solutions boiled together, a buff-coloured precipitate is obtained which behaved like that obtained in the above experiment.

The potassium cyanide then acts upon the undecomposed silver ferridcyanide and reduces it to silver ferrocyanide.

This reaction was proved by direct experiment—



The final change of the precipitate to black is due to reduction of silver.

When precipitated, silver oxide and silver ferrocyanide are boiled together with water, the colour changes from brown to black, and silver cyanide, silver ferridcyanide, and metallic silver are formed—



If silver ferridcyanide is boiled with silver oxide, there is no blackening, but formation of a pink precipitate containing the compound of silver cyanide and ferridcyanide, together with free silver cyanide (soluble in ammonia) and ferric oxide:— $2\text{Ag}_3\text{FeCy}_6 + 3\text{Ag}_2\text{O} = 12\text{AgCy} + \text{Fe}_2\text{O}_3$.

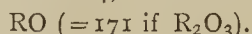
King's College, London.

ON SAMARIUM AND ITS COMPOUNDS.

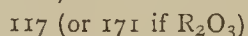
By Prof. P. T. CLEVE, Hon. Member of the Chemical Society.

Introduction.

IN the year 1878 Delafontaine found, on examining impure didymia, extracted from samarskite, some new absorption-bands, which did not belong to didymium but to an unknown element of higher atomic weight. He named this metal *decipium*. Some time later Lecoq de Boisbaudran found also in the fractions, rich in didymia, which were extracted from samarskite, a new oxide, distinguished by its absorption-spectrum and by peculiar spark-lines. The oxide was thrown down with ammonia before that of didymium. He called the metallic radical *Samarium*, and described more exactly than Delafontaine its absorption-spectrum. In March, 1880, Delafontaine published in the *Bibliothèque universelle de Genève* a paper "On the Atomic Weight and the Compounds of Decipium." The atomic weight was found to be 114, if the oxide be—



The salts were colourless and the sulphate less soluble than the sulphate of didymium. Shortly afterwards Marignac published his researches on the earths which in the samarskite accompany terbia, and found an oxide, named Yβ, distinguished by its yellow salts, its spectrum of absorption agreeing with that of samarium. The atomic weight of the metal was found, as a maximum 99.6, if the oxide be RO (=179.4 if R_2O_3), thus differing widely from the figures given by Delafontaine. The latter has more recently found that the decipia of 1878 could be split up into an oxide without absorption-spectrum, for whose radical, of the atomic weight—



he reserved the name of decipium, and another oxide with the spectrum described by Lecoq de Boisbaudran. He adopted the name of samarium for the metal which has as a maximum the atomic weight 101 (or 151.5 if R_2O_3).

Method of Extraction.

The raw material which I used for extracting the oxide of samarium consisted principally of a mixture of almost all the rare oxides of the earth-metals, which were obtained from Dr. Paijkull, in Stockholm, and said to be derived from orthite found at Arendal in Norway. As the matter, about 10 kilos., contained almost 10—12 per cent thorina, it may be assumed that a considerable quantity of thorite may have been mistaken for orthite. The mixture of earths was mixed with nitric acid and heated in china basins till it began to give off red vapours. After cooling, the mass was treated with water, which left undissolved a large quantity of basic nitrates, principally of cerium and thorium. These basic nitrates were insoluble in saline liquids, but dissolved in pure water, forming

opalescent solutions. They were separated by decantation and filtering, and washed as long as the liquid went clear through the filter. The basic salts were mixed with strong sulphuric acid, and the solution of the sulphates in cold water was precipitated with large quantities of hot water, by which operation most of the cerium was separated as basic sulphate.

The solution was then precipitated with caustic soda, and the hydrate, principally of thorium, dissolved in diluted sulphuric acid. On evaporating off the solution, large and bulky masses of thorium sulphate were obtained. The oxides which remained in the mother-liquors were transformed into nitrates and added to the solution of nitrates obtained by the first operation. These nitrates were evaporated, and the residuum was heated in platinum basins till it began to give off red vapours. On treating the heated mass with water, a solution free from cerium and thorium was obtained.

By this treatment also considerable quantities of the nitrates of the more positive metals, yttrium, didymium, &c., were decomposed, and separated together with the thorium and cerium, and to complete the separation, the basic nitrates were once again and carefully treated in the same manner. The solutions free from the oxides of cerium and thorium, or containing only small traces of these oxides, were precipitated with potassium sulphate with the view of separating the cerium- and yttrium oxides, of which the former were (incompletely) precipitated, and the latter (incompletely) retained in the solution.

The yttrium earths (about 700 grms.) were transformed into nitrates and subjected to the usual melting-process, for separation of erbia from yttria, terbia, and didymia, which offer greater resistance to the action of heat. From the basic nitrates first obtained a small quantity (about 1.5 grms.) of scandium oxide was separated.* They contained also a very small quantity of thulium, some erbia and ytterbia, and a considerable portion of holmia. The fractions containing yttria and didymia were saturated with potassium sulphate, and this precipitate was added to the similar precipitate formerly obtained. These difficultly soluble double sulphates were decomposed with boiling potash-ley, and the hydrates dissolved in diluted sulphuric acid were again treated with potassium sulphate. In the solution there then remained considerable quantities of terbia (about 200 grms. impure earth). The precipitate was converted into nitrate and its solution evaporated. The residue was then heated to partial decomposition in order to separate the last remaining traces of thorium and cerium.

The soluble nitrates thus obtained, which contained principally didymium and lanthanum, but also samarium, terbium, yttrium, &c., were mixed with impure didymium, extracted from various minerals, as cerite, gadolinite, keilhauite, &c., and then subjected to partial precipitation with cold dilute ammonia. The last fractions contained much lanthanum, which was separated partly by the Mosander method, and partly by precipitation with ammonia. No oxide intermediate between that of lanthanum and that of didymium could be obtained, although I sacrificed much time in searching for such an oxide. The first precipitations were repeatedly treated in the same manner with dilute ammonia. In this way I obtained several fractions containing both terbia and didymia (samarium, &c.). They were again treated several times with sulphate of potash.

The slightly soluble double sulphates were now decomposed, and the solution of the hydrates in nitric acid was repeatedly precipitated with ammonia. I obtained finally the following fractions:—

1: about 67 grms. light-coloured oxides, whose solution was very little coloured, but showed, besides the spectrum of samarium, also the spectrum of didymium. Atomic weight R = 149—159.

* No scandium could be obtained from the precipitate with sulphate of potassium.

2:	about 4 grms. oxide;	At. wt. R=148
3:	" 1'7 "	" =146'2
4:	" 6 "	" =143'7
5:	" 150 "	" =142'7
6:	" 29 "	" =142'3

The sixth fraction was subjected to partial precipitation with ammonia, but the atomic weight of the four fractions thus obtained was still found to be 142'3.

This is a proof of the correctness of my latest determinations of the atomic weight of didymium, which gave the same numbers. No lanthanum was present in these fractions. As the fractions intermediate between the pure or almost pure didymium and the samarium are only trifling, there is very little probability of finding any unknown element intermediate between samarium and didymium.

The 67 grms. of earths containing the principal quantity of samarium were now subjected to the same treatment with dilute ammonia, until the absorption-spectrum of didymium was completely eliminated. The oxides freed from didymium were far from pure samarium oxide, and I was therefore obliged to precipitate their solutions with potassium sulphate.

At first I several times used solutions with 2 per cent oxide, and later with only $\frac{1}{2}$ per cent. Terbium and other oxides (Ya, decipium) were thus eliminated together with much samarium oxide. The treatment with potassium sulphate was continued until the oxide, which remained in the solution, had the same molecular weight as the oxide thrown down, or $R''' = 150$.

A considerable quantity of samaria was separated at the same time as terbium and Ya, for which reason I was obliged to subject these oxides to the same treatment, whereby I finally obtained the fractions used for the atomic weight determinations A and B, A being oxide left in the solution, and B precipitated as double sulphate.

I have described this method, as long experience has has convinced me that the coarse separation of all the rare earths may be most conveniently effected thereby.

Atomic Weight of Samarium.

The samarium oxide, obtained as above described, was purified by treatment with sulphuretted hydrogen, repeated precipitation of the solution with ammonia, and finally in acid solution with pure oxalic acid. The oxide obtained by calcination of the oxalate was dissolved in pure nitric acid, and by precipitation with freshly distilled ammonia, divided into four fractions, I., II., III., IV. These were transformed into oxalate and oxide. The four fractions thus obtained were subjected to atomic weight determinations in the usual way, by solution in nitric acid, addition of sulphuric acid, and estimation of the sulphates. The fractions A and B were obtained, as stated in the foregoing section, from the samarium oxide which remained in the solution of potassium sulphate.

The atomic weight determinations gave the following results:—

	Oxide Sm ₂ O ₃ .	Sulphate.	Per cent of oxide in the sulphate.	At.wt.(SO ₃ =80.)
I.	1'6735	2'8278	59'180	149'975
II.	1'9706	3'3301	59'175	149'940
III.	1'1122	1'8787	59'201	150'120
IV.	1'0634	1'7966	59'190	150'045
A.	0'8547	1'4440	59'190	150'045
B.	0'7447	1'2583	59'183	150'000

As a mean of these six closely agreeing experiments, the atomic weight is 150'021, or in round numbers 150. In the calculation I have supposed the oxide to be Sm₂O₃, which follows beyond doubt from its chemical properties, that is from the composition of the chloroplatinate, of the samarium and ammonium sulphate, and of the selenite. Whether samarium gives other oxides besides Sm₂O₃ is a point which I have not yet determined. As to its position in the system of Mendelejeff, I think it may most proba-

bly be placed in the 8th group, on the 8th line, where there is a gap for a group of unknown elements.

Spectrum of Samarium.

The salts of samarium are distinguished by a peculiar spectrum, composed of several bands, among which four in the blue part of the spectrum are most characteristic. The absorption-spectrum has been examined by Lecoq de Boisbaudran and by Thalén. The latter used a solution of the nitrate prepared by myself.

Both found about the same bands, viz:—

Numbers.	Wave-length according to	
	Lecoq de Boisbaudran.	Thalen.
I.	559	556—559
II.	551—500	501'5—497
III.	489 (indistinct)	—
IV.	486—474	486 —472 strong
V.	464—463	466 —460 strong
VI.	—	445 —437 not strong
VII.	417	418'5—415
VIII.	400'75	409 (limit not visible).

The intensity of the absorption is not very great, so that the absence of these bands in didymium salts cannot be regarded as a sure test for the absence of samarium.

The spark-spectrum of samarium has been examined by Professor Thalén, who will soon publish his results. He has found about 150 lines scattered over the whole spectrum, except the red part. They are all of little intensity. Many among these lines were mapped by him in connection with his examination of the spectrum of didymium in the year 1873 (*Kongl. Svenska Vetensk.-Akad. Handlingar*, t. xii., No. 4). The didymia, which I regarded at that time as pure, was thus a mixture of didymia and samaria, which is also apparent from the atomic weight 147, instead of 142'3.

Compounds of Samarium.

Oxide of Samarium, Sm₂O₃, is a white powder, with a scarcely perceptible yellowish tint. If yellow it contains terbium. It is easily soluble in acids, and gives with them salts whose solutions are intensely yellow. The crystallised salts are topaz-coloured, but in the state of powder they are white, with a yellowish tint.

The *hydroxide* is a gelatinous, white, or indistinctly yellowish precipitate, insoluble in alkalis. It is a stronger basic than yttria, but not so strong as didymia.

Chloride of Samarium, SmCl₃·6H₂O, crystallises in large tabular crystals, which are deliquescent. Pressed between paper, as were all the following salts, it gave by analysis the following results:—

0'5708 grm. gave 0'6647 grm. AgCl.

0'7375 grm. gave 0'3513 Sm₂O₃, precipitated as oxalate.

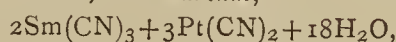
	In per cent.	Calc.	Found.
Sm		41'15	41'06
Cl		29'22	28'79

Chloroplatinate of Samarium, SmCl₃·PtCl₄·10 $\frac{1}{2}$ H₂O, crystallises over sulphuric acid in orange-coloured prisms, which are deliquescent, and lose at 110° 8'71 per cent H₂O (4 mols. = 9'20).

0'5775 grm. gave 0'3611 grm. Sm₂(SO₄)₃+Pt, which left on washing with water 0'1402 grm. Pt.

	Calc.	Found.
Pt	24'92	24'22
Pt + Sm ₂ SO ₄	62'49	62'53

Platinocyanate of Samarium,—



obtained by double decomposition of the barium salt with the sulphate, crystallises in well-developed yellow prisms, which reflect blue light. It is unchangeable in the air, and loses at 110° 16'33 per cent. H₂O (14 mols. = 16'57).

0.6963 grm. gave 0.5396 grm. $\text{Sm}_2\text{SO}_4 + \text{Pt}$, which left by washing with water 0.2694 grm. Pt.

	Calc.	Found.
Pt.	38.46	38.69
Pt + Sm_2SO_4 . .	77.12	77.49

Nitrate of Samarium, $\text{Sm}(\text{NO}_3)_3 + 6\text{H}_2\text{O}$, crystallises in easily soluble prisms of pale yellowish colour. 1.0969 grms. left by ignition 0.4274 grm. Sm_2O_3 .

	Calc.	Found.
Sm_2O_3	39.19	38.96

Acetate of Samarium, $\text{Sm}(\text{C}_2\text{H}_3\text{O}_2)_3 + 4\text{H}_2\text{O}$, forms short, well-developed prisms, moderately soluble in water. 0.7886 grm. lost by 110° 0.1393 grm. H_2O , and gave by ignition 0.3444 grm. Sm_2O_3 .

0.8688 grm. lost 0.1546 grm. H_2O , and gave 0.3802 grm. Sm_2O_3 .

	Calc.	Found
Sm_2O_3	43.61	43.67—43.76
H_2O	18.05	17.66—17.79

Sulphate of Samarium, $\text{Sm}_2(\text{SO}_4)_3 + 8\text{H}_2\text{O}$, obtained by evaporating on the water-bath a solution of the nitrate mixed with sulphuric acid, forms well-developed brilliant crystals, much less soluble in water than sulphate of didymium.

0.8966 grm. lost by careful heating 0.1763 grm. H_2O .

0.8240 grm. lost 0.1620 grm. H_2O .

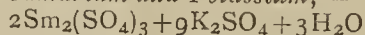
Both experiments gave 19.66 per cent H_2O instead of 19.67.

Selenate of Samarium, $\text{Sm}_2(\text{SeO}_4)_3 + 8\text{H}_2\text{O}$, is easily soluble in water, but in other respects resembles the sulphate.

0.9881 grm. lost by careful heating over the open fire, 0.1642 grm., and left by heating to white-red, 0.3951 grm. Sm_2O_3 .

	Calc.	Found.
Sm_2O_3	39.86	39.99
H_2O	16.49	16.62

Sulphate of Samarium and Potassium, —



was slowly deposited as a white powder, when acetate of samarium was added to an excess of sulphate of potassium. It is very little soluble in a saturated solution of sulphate of potash. It is difficult to state in figures the solubility, as it seems to be much dependent on the temperature and the more or less quantity of free acid present. I have generally found that 1 litre of the saturated solution contains about $\frac{1}{2}$ grm. of samarium oxide.

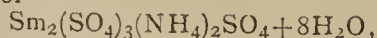
1.2545 grms. lost by heating 0.0246 grm. H_2O (hygroscopic?). The anhydrous salt was dissolved in water, acidulated with HCl , and precipitated with ammonia. The basic sulphate was again dissolved and precipitated. The solutions were evaporated, and gave 0.7229 grm. K_2SO_4 . The oxide of samarium, precipitated as oxalate, amounted to 0.3157 grm.

	Calc.	Found
Sm_2O_3	24.87	25.17
K_2O	30.31	31.00
H_2O	1.93	1.96

I have before analysed a compound of didymium, having the same composition.

Sulphate of Samarium and Ammonium, —

$\text{Sm}_2(\text{NH}_4)_2(\text{SO}_4)_4 + 8\text{H}_2\text{O}$, or



crystallises from the mixed solutions of the simple sulphates containing excess of ammonium sulphate, in small tabular crystals.

0.7168 grm. lost by 110° 0.0935 grm. H_2O , and left by heating to white-red, 0.2888 grm. Sm_2O_3 .

	Calc.	Found.
Sm_2O_3	40.28	40.29
$\text{H}_2\text{O}(\frac{6}{8})$	12.50	13.04

Selenite of Samarium, $\text{Sm}_2\text{O}_3 \cdot 4\text{SeO}_2 + 5\text{H}_2\text{O}$, was thrown down by addition of selenious acid to the solution of the acetate as a bulky precipitate, which was very soon transformed into microscopic needles.

0.8312 grm. lost by 110° 0.0523 grm. H_2O , and gave 0.2935 grm. Se, and 0.3233 grm. Sm_2O_3 , precipitated as oxalate.

0.8910 grm. gave 0.0560 H_2O , 0.3175 grm. Se, and 0.3465 grm. Sm_2O_3 .

	Calc.	Found.
Sm_2O_3	39.46	38.90—38.89
SeO_2	50.34	49.61—50.07
$\text{H}_2\text{O}(\frac{5}{8})$	6.12	6.29—6.28

Oxalate of Samarium, $\text{Sm}_2(\text{C}_2\text{O}_4)_3 + 10\text{H}_2\text{O}$, is a white or pale-yellowish crystalline precipitate. From concentrated solutions it is first thrown down as a viscid, yellowish mass, which soon hardens.

1.0029 grm. lost by 110° 0.1516 grm. H_2O , and gave by ignition 0.4638 grm. Sm_2O_3 .

	Calc.	Found.
Sm_2O_3	46.77	46.25
$\text{H}_2\text{O}(\frac{10}{8})$	14.52	15.12

The salts of samarium agree closely in composition with the didymium salts; and of all elements, samarium is most nearly related to didymium, less closely to the yttria metals, the platynocyanates of the latter being wholly different from the samarium salt, which resembles the corresponding salts of cerium, lanthanum, and didymium.—*Journal of the Chemical Society*, August, 1883.

TRANSMISSION OF GASES THROUGH FLUIDS OF DIFFERENT DENSITIES.

A LECTURE EXPERIMENT.

By C. GILBERT WHEELER.

If in a given acidified and nearly saturated solution of a salt (I have generally used ferrous sulphate and added a small quantity of sulphuric acid) a piece of zinc is placed, and this solution carefully overlaid with common water, the bubbles of hydrogen appear to meet with considerable resistance at the zone of contact between the two liquids, and from one-third to one-half are reflected downward and to one side. Finally, however, they are again induced by their relative levity to rise; and now scattered, and at a part of the vessel remote from their first ascent, pass through the upper zone and escape into the air.

This phenomenon is again exhibited if upon the second or upper stratum a third liquid is superimposed having a density less than that of water. The appearances at this second zone are, however, not quite as marked as at the first.

What is the cause of this apparent reflection of the hydrogen bubbles in passing from a denser into a rarer medium? I confess that at present a wholly satisfactory explanation does not occur to me.

Certainly it does not appear reasonable that the circumstance of their meeting with less resistance on entering the rarer medium should occasion a reflection, though by virtue of the reduced difference between the densities of the æriform body in this second stratum and its enveloping fluid it is conceivable why, perhaps, a less rapid upward movement should result. Is not, however, this influence in favour of a less rapid movement more than compensated for by the diminished resistance of this second medium? Be this as it may, it still cannot explain, I think, why there is a positive reflection of a large part of the bubbles. It might explain a mere retarding in their movement.

In explanation of the above phenomenon it may also be assumed that the bubbles of gas as they rise from the

saline liquid into the water above carry with them their envelope, *i.e.*, the thin film of solution encircling them. When, therefore, they enter the upper liquid they are too much weighted down to pass at once through the latter, and are therefore detained for an instant. In the meanwhile they are caught by the descending current of the solution, and are for a time carried sideways and downwards. This downward current is caused as a result of the upward current formed by the rapid ascent of the hydrogen set free by the zinc. I am devising experiments to settle this, if possible, and hope soon to report.—
American Chemical Journal.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF WATER SUPPLIED TO LONDON DURING THE YEAR 1882.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

London, May 30th, 1883.

SIR,—We beg to submit, for the information of the Local Government Board, a statement and discussion of the general results of our examination, made at the expense of the Water Companies of the 2110 samples of water collected by us during the year 1882, from the mains of the seven London Companies taking their supply from the Thames and Lea.

Of these 2110 samples of water, 299 were taken from the mains of the New River Company, 303 from the mains of the East London Company, 300 from the mains of the Chelsea Company, 302 from the mains of the West Middlesex Company, 304 from the mains of the Lambeth Company, 301 from the mains of the Grand Junction Company, and 301 from the mains of the Southwark and Vauxhall Company.

Since we commenced the work of our monthly Reports, in December 1880, we have examined and reported on 4291 samples of water.

We are, Sir,
Your obedient Servants,

WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

To the Secretary of the Local Government Board.

Colour of the Water.

We have continued to employ the colour-meter, described by us in previous Reports, for the purpose of registering the daily colour of the various samples of water submitted by us to examination. Without for a moment suggesting that it is incapable of further improvement, a large experience in its use warrants us in affirming that it affords far more accurate results than the rough methods heretofore and still made use of by chemists in general.

In Tables I. to VII. will be found recorded the results of our daily examinations of the colour presented by the water supplied by the several Companies. We have further expressed these results diagrammatically in wave diagrams which will be found at the end of the Report.

Clearness.

For want of better, we continue to employ the arbitrary terms of "turbid," "slightly turbid," and "very slightly turbid;" giving to these terms the special signification explained in previous reports.

Of 299 samples collected from the mains of the New River Company, the whole without a single exception were clear, bright, and well filtered.

Of 303 samples from the mains of the East London Company, six were found to be "very slightly turbid," and two "slightly turbid." The remaining 297 were clear, bright, and well filtered.

Of 300 samples from the mains of the Chelsea Company, one was recorded as "turbid," one as "slightly turbid," and one as "very slightly turbid," the remaining 297 samples being clear, bright, and well filtered.

Of 302 samples from the mains of the West Middlesex Company, one was recorded as "slightly turbid," and two as "very slightly turbid," the remaining 299 samples being clear, bright, and well filtered.

Of 304 samples from the mains of the Lambeth Company, eleven were recorded as "very slightly turbid," and two as "slightly turbid." The remaining 296 samples were clear, bright, and well filtered.

Of 301 samples from the mains of the Grand Junction Company, ten were recorded as "very slightly turbid," and two as "slightly turbid." The remaining 289 samples were clear, bright, and well filtered.

Of 302 samples from the mains of the Southwark and Vauxhall Company, ten were recorded as "very slightly turbid," and two as "slightly turbid." The remaining 294 samples were clear, bright, and well filtered.

Summarising these results, we found 40 samples "very slightly turbid," 10 "slightly turbid," and 1 "turbid," leaving 2059 samples entirely free (so far as unaided vision could determine) free from suspended matters.

Of the total 51 samples not entirely free from suspended matter 35 were coincident with and dependent on the occurrence of periods of violent rain-fall, namely 15 samples in March-April, 7 samples in July, and 13 samples in October.

Free Oxygen.

In Tables IX. to XV. we have recorded, in cubic inches per gallon, the quantity of free oxygen in the whole of the samples examined. The mean result of the two hundred or so determinations, made by us every month, are set forth in the tabular statement given below; from which it appears that the quantity of free oxygen in the water ranges from $1\frac{3}{4}$ to $2\frac{1}{2}$ cubic inches per gallon, the quantity varying inversely with the temperature, in accordance with the law of the variation of gas-solubility with temperature. Practically, the water has been found to be throughout the year fully aerated or oxygenated. To the series of experiments on this subject, at present carried out exclusively by ourselves, and to the general result obtained, we attach considerable importance, as demonstrating the high character of the metropolitan water in respect to its freedom from putrescent matter.

	Oxygen in cubic inches per Gallon.	Mean temperature of air.
January	2.16	40.2
February	2.25	41.1
March	2.18	46.1
April	2.09	47.9
May	1.93	53.5
June	1.89	56.3
July	1.78	60.2
August	1.74	60.3
September	1.85	53.8
October	1.96	51.2
November	2.12	41.3
December	2.21	40.3

Ammonia and Organic Matter.

In Table XVI. will be found recorded the quantities of free or saline ammonia present in the 272 samples of water examined. It is noteworthy that the 1-500th of a grain of ammonia per gallon was the maximum amount found, and this on 12 occasions only. On 68 occasions

the rooth of a grain per gallon was recorded; whilst 192 examinations revealed no appreciable trace of ammonia whatsoever.

The actual organic matter present has been estimated by determining the oxygen required to oxidise the organic matter, and by combustion. In estimating the oxygen required, we have adopted the method described in detail by one of our number in the *Journal of the Chemical Society* (vol. xxxv., p. 46, 1879); while in the combustion process, we have followed the lines laid down by Frankland and Armstrong. The oxygen required to oxidise the organic matter has been estimated in 7 samples daily, viz., a sample from each Company's supply, and our results are summarised and arranged in Tables XVII. to XXIII. The organic carbon and nitrogen have been estimated in one sample daily, and our results are given in Table XXIV. We have in this Table given also, in a companion column, the quantities of oxygen necessary to oxidise the organic matter in the same samples.

In our last year's Report we drew attention to some broad facts, which an examination of the curves, plotted from the Tables, brought out very prominently. These were the close parallelism which existed between the amount of organic carbon, as determined by the combustion process, and the amount of oxygen required to oxidise the organic matter, as determined by permanganate. We showed that, despite some some irregularities the two quantities sank together as the summer came on, and rose again towards the winter. Indeed this similarity extended to the minor fluctuations, and these were so concordant as to lead us to suggest that, for practical purposes of water analysis, the oxygen process afforded indirectly a trustworthy measure of the amount of organic carbon present in a water. This relationship, showing such a close agreement in results between the combustion and the oxygen processes of carbon determination, was not seen to extend so fully to the colorimetric process. But though the connection between the greater or less colour-tint of the waters and the organic carbon was not so obvious, still we drew attention to the fact that the broad fluctuations, corresponding to the fall in summer and rise in winter, were well marked, while some of the more decided oscillations were likewise reproduced.

We have now the gratification of being able to show that the connection between the brown colour of the Metropolitan waters and the amount of organic carbon they contain, which was suspected last year, proves to be strikingly close.

The same facts have presented themselves this year as last year, but, more fortunate than before, we are able to show their real import. The scale on which last year's curve was plotted was too small. In the present curves we have merely lengthened the ordinates representing the brown colouration, so as to make the colour scale comparable with the scales of the combustion and permanganate results, and the suspicion of last year now becomes a certainty.

The curves representing the "organic carbon" and "oxygen required" are on the same scale as before, but the scale of the "brown colour" curve has been enlarged five times; whilst the blue colour, proving a constant quantity in all the waters, has been suppressed as unnecessary.

The three curves are now seen to correspond so closely as to force on us the conviction that the same cause is at work in all three instances. The amount of organic carbon present in the water is the active ingredient in each case. In the upper curve it reveals itself by its power of reducing permanganate of potash. In the middle curve it registers the number of parts of carbon present in 100,000 parts of water. In the lower curve the organic carbon actually shows itself to the eye by darkening the water, and so enabling itself to be measured by a mere inspection in the colorimeter.

Taking the amount of organic carbon in a water to be a measure of the organic matter present, these curves show

that, at all events in the case of the waters supplied to the metropolis, a very fair estimate of their purity in respect to organic matter may be made by mere optical examination.

The relationship thus exhibited goes far to establish the usefulness of the colorimetric mode of examination introduced and employed by ourselves, and its value as an improvement on the rougher methods still in common use.

Nitrogen (as Nitrates and Nitrites) and Chlorine.

These have been estimated in daily samples of the waters, and the results are stated in Tables XXV. and XXVI. The quantity of nitrogen, in the form of nitrate or nitrite, ranges from about one and a quarter tenths of a grain to two and a quarter tenths of a grain per gallon, the quantity being on the average somewhat lower in the summer and autumn than in the winter and spring quarters. The variation with season in the quantity of chlorine or common salt present in the waters is not very obvious. The quantity of chlorine amounts throughout the year to either close upon, or a little over, one-tenth of a grain per gallon.

Hardness.

The degree of hardness has been estimated in a daily sample of the water, and our results are given in Table XXVII.

With regard to the mineral matter held in solution in the waters, it consists mainly of the carbonates of the alkaline earths, with a small quantity of sulphates, nitrates, and chlorides. No one suggests that the presence of these salts in the water is prejudicial to health; while there is, on the contrary, some reason to believe that they are actually useful to the animal economy, as one means of supplying constituents required for the organism.

(To be continued.)

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.
Chief Chemist to the U.S. Geological Survey, Washington.

NITROGEN.

THE atomic weight of nitrogen has been determined from the density of the gas, from the ratio between ammonium chloride and silver, and from the composition of certain nitrates.

Upon the density of nitrogen a great many experiments have been made. In early times this constant was determined by Biot and Arago, Thomson, Dulong and Berzelius, Lavoisier, and others. But all of these investigations may be disregarded as of insufficient accuracy; and, as in the case of oxygen, we need consider only the results obtained by Dumas and Boussingault and by Regnault.

Taking air as unity, Dumas and Boussingault* found the density of nitrogen to be—

0.970

0.972

0.974

Mean 0.972 ± 0.00078

For hydrogen, as was seen in our discussion on the atomic weight of oxygen, the same investigators found a mean of 0.0693 ± 0.00013 . Upon combining this with the above nitrogen mean, we find for the atomic weight of the latter element, $N = 14.026 \pm 0.0295$.

* Smithsonian Miscellaneous Collections. "The Constants of Nature."

† *Comptes Rendus*, 12, 1805. 1841.

By Regnault* much closer work was done. He found the density of nitrogen to be as follows:—

0.97148
0.97148
0.97154
0.97155
0.97108
0.97108

Mean 0.97137 \pm 0.000062

For hydrogen, Regnault's mean value is 0.069263 \pm 0.000019. Hence, combining as before, $N = 14.0244 \pm 0.0039$.†

The value found by combining both series of experiments is $N = 14.0244 \pm 0.0039$.

In discussing the more purely chemical ratios for establishing the atomic weight of nitrogen, we may ignore, for the present, the researches of Berzelius, of Anderson, and of Svanberg. These chemists experimented chiefly upon lead nitrate, and their work is consequently now of greater value for fixing the atomic weight of lead. Their results will be duly considered in the proper connection further on.

The ratio between ammonium chloride and silver has been determined by Pelouze, by Marignac, and by Stas. The method of working is essentially that adopted in the similar experiments with the chlorides of sodium and potassium.

For the ammonium chloride equivalent to 100 parts of silver, Pelouze‡ found:—

49.556
49.517

Mean 49.5365 \pm 0.013

Marignac|| obtained the following results. The usual ratio for 100 parts of silver is given also:—

8.063	gram.	Ag = 3.992	gram.	NH ₄ Cl.	49.510
9.402	"	4.656	"		49.521
10.339	"	5.120	"		49.521
12.497	"	6.191	"		49.540
11.337	"	5.617	"		49.546
11.307	"	5.595	"		49.483
4.326	"	2.143	"		49.538

Mean 49.523 \pm 0.0055

But neither of these series can for a moment compare with that of Stas.§ He used from 12.5 to 80 grms. of silver in each experiment, reduced his weighings to a vacuum standard, and adopted a great variety of precautions to insure accuracy. He found for every 100 parts of silver the following quantities of NH₄Cl:—

49.600
49.599
49.597
49.598
49.597
49.593
49.597
49.5974
49.602
49.597
49.598
49.592

Mean 49.5973 \pm 0.0005

Now, combining these three series we get:—

Pelouze	.. .. .	49.5365 \pm 0.013
Marignac	.. .. .	49.523 0.0055
Stas	.. .. .	49.5973 0.0005

General mean 49.597 \pm 0.0005

The quantity of silver nitrate which can be formed from a known weight of metallic silver has been determined by Penny, by Marignac, and by Stas. Penny* dissolved silver in nitric acid in a flask, evaporated to dryness without transfer, and weighed. One hundred parts of silver thus gave of nitrate:—

157.430
157.437
157.458
157.440
157.430
157.455

Mean 157.4417 \pm 0.0033

Marignac's† results were as follows. In the third column they are reduced to the common standard of 100 parts of silver.

68.987	gram.	Ag gave 108.608	AgNO ₃	157.433
57.844	"	91.047	"	157.401
66.436	"	104.592	"	157.433
70.340	"	110.718	"	157.404
200.000	"	314.894	"	157.447

Mean 157.4236 \pm 0.0061

Stas,‡ employing from 77 to 405 grms. of silver in each experiment made two different series of determinations at two different times. The silver was dissolved with all the usual precautions against loss and against impurity, and the resulting nitrate was weighed, first after long drying without fusion just below its melting-point; and again, fused. Between the fused and the unfused salt there was in every case a slight difference in weight, the latter giving a maximum and the former a minimum value.

In Stas' first series there are eight experiments; but the seventh he himself rejects as inexact. The values obtained for the nitrate from 100 parts of silver are given below in two columns, representing the two conditions in which the salt was weighed. The general mean given at the end I have deduced from the means of the two columns considered separately:—

Unfused.	Fused.
157.492	157.474
157.510	157.481
157.485	157.477
157.476	157.471
157.478	157.470
157.471	157.463
157.488	157.469

Mean 157.4857 Mean 157.472
General mean 157.474 \pm 0.0014

In the later series there are but two experiments as follows:—

Unfused.	Fused.
157.4964	157.488
157.4940	157.480

Mean 157.4952 Mean 157.484
General mean 157.486 \pm 0.0003

Now to combine all four sets of results:—

* *Comptes Rendus*, 20, 975. 1845.
† Professor Le Conte, in his corrections of Regnault's calculations, already cited in a foot note to the chapter on oxygen, finds for the density of nitrogen the value 0.971346. Hence $N = 14.0225$. This correction is very slight, but it should be considered in any future revision of the atomic weights.

‡ *Comptes Rendus*, 20, 1047. 1845.

|| "Berzelius's *Lehrbuch*," 5th edition, vol. iii., 1184, 1185.

§ "Aronstein's Translation," pp. 56-58.

* *Phil. Trans.*, 1839.

† "Berzelius's *Lehrbuch*," 5th edition, iii. pp. 1184, 1185.

‡ "Aronstein's Translation," pp. 305 and 315.

Penny	157'4417 ± 0'0033
Marignac	157'4236 0'0061
Stas, 1st series	157'4740 0'0014
Stas, 2nd series	157'4860 0'0003

General mean 157'479 ± 0'0003

For the direct ratio between silver nitrate and silver chloride there are two series of estimations. A weighed quantity of nitrate is easily converted into chloride, and the weight of the latter ascertained. In two experiments Turner* found of chloride from 100 parts of nitrate:—

84'357
84'389

Mean 84'373 ± 0'011

Penny† in five determinations, found the following percentages:—

84'370
84'388
84'377
84'367
84'370

Mean 84'3744 ± 0'0025

The general mean from both series is 84'3743 ± 0'0025.

(To be continued.)

NOTICES OF BOOKS.

Reports of Trials for Murder by Poisoning by Prussic Acid, Strychnia, Antimony, Arsenic, and Aconita. Including the Trials of Tawell, Palmer, Dove, Madeline Smith, Dr. Pritchard, Smethurst, and Lamson, with Chemical Introduction and Notes on the Poisons used. By G. LATHOM BROWNE, of the Midland Circuit, Barrister at-Law, and C. G. STEWART, Senior Assistant in the Laboratory of St. Thomas's Hospital, Associate of the Royal College of Science, Dublin, and of the Society of Public Analysts. London: Stevens and Sons.

WE have here a most interesting and important work, the joint product of a barrister and a chemist, and dealing with poisons and their administration both from a legal and a medico-chemical point of view. The discovery of poisons in the animal system and the detection of the guilty person are shown, not merely in theory, but as they have actually occurred in the most celebrated cases of the last half-century. The toxicologist, as he studies this volume finds himself brought face to face with the difficulty of proving to the satisfaction of a jury the presence of any given poison in the intestines, &c., of the supposed murdered person. He finds recorded the objections and the doubts which have been raised, and which, under similar circumstances, would be sure to recur, and he learns how to avoid or to overcome them.

In the first chapter our authors give a "chemical introduction." They give a notice of the manner of death and of the characteristic symptoms as giving a clue to the fact that poison has been taken, and secondly to the particular kind. They point out that in medical evidence on the individual poisons, those physiologically resembling the one concerned are always most heard of at the trial, and questions are asked whether some other cause may not have produced the same symptoms.

We find next an account of the vegetable bases, the processes for their separation, and their characteristic reactions. This part of the subject naturally leads to a

consideration of the ptomaines or cadaveric alkaloids of Selmi, Gautier, &c. The existence of these bodies raises a fresh difficulty, and raises a new and plausible line of defence. It is here admitted that there is no general method known of distinguishing the cadaveric alkaloids, as a class, from the vegetable bases. But they add, very justly, that there is no ptomaine known which gives *all* the reactions of strychnine. Hence, if the chemist is asked—"Could any other substance produce these reactions?" he can only answer, "I do not know of any." Amongst a number of general principles laid down at the end of this chapter, two especially deserve notice. It is said that unhealthy or improper food, or acute disease, may cause suspicious symptoms." Of this there have been very numerous instances. Death has followed, *e.g.*, after eating cheese, under symptoms which seemed to point decidedly to a mineral irritant; yet, on careful analysis, no trace of arsenic, mercury, antimony, &c., could be detected.

The following seems to us to demand partial rectification:—"In experiments on animals, it may be objected that they are inconclusive as to man. This is not strictly true. But if a *recent vomit* proves poisonous to an animal with the same symptoms as in the man, that is almost conclusive evidence." We should argue that difference of symptoms is not the slightest objection if the symptoms in either case are accurately known. Suppose that an alkaloid, *x*, produces in a man certain symptoms which we may call *a, b, c*, &c., but in a dog another set of symptoms, *l, m, n*, &c. If a man displays the symptoms *a, b, c*, and if the matter which he has vomited, or an extract from the contents of his stomach or liver, produce in a dog the symptoms *l, m, n*, the evidence is then altogether as conclusive as if the symptoms in the two cases were alike. Our authors, therefore, would have done well to omit the words "with the same symptoms as in the man," and to have used some more emphatic form of dissent than "This is not strictly true."

There is a caution which the authors seem to have overlooked. It is this: If a body has been exhumed after lying for some time in the grave, and if, *e.g.*, arsenic is found in the remains, it may be contended,—in fact, it has actually been done—that the poison has been absorbed after death from the surrounding soil, or from other bodies in the same grave. In such cases, therefore, it is well, when exhuming the body, to secure samples of the soil at different distances, and submit them to a quantitative examination for the same poison found in the body.

In the succeeding chapters the authors go on to report and discuss trials for poisoning with the best-known deadly drugs, beginning with prussic acid. Here we have, first, the once well-known case of John Tawell, who was tried at Aylesbury, in 1845, for the murder of his mistress, Sarah Hart. Among the principal points of this case was the puerile attempt made by counsel for the defence to show that the hydrocyanic acid found in the stomach of the deceased might have been derived from apple-pips! The deceased woman had undoubtedly been eating apples, and their pips certainly contain a trace of hydrocyanic acid. But, according to an authority, it would be necessary to take the pips of from 18 to 135 lbs. of apples (according to quality) to furnish a poisonous dose of the acid. Further, few people, when eating apples, swallow the pips; those which are swallowed escape mastication, and are voided unchanged. Hence it may truly be said "that of fruits an impossibly large quantity must be eaten to produce any considerable amount of hydrocyanic acid." Reference is made to the evidence of one Henry Thomas, a druggist's assistant, said to have been in communication with the prisoner's solicitor, who swore that "15 small apples gave 2½ grains of silver cyanide," equal to 0.46 of anhydrous hydrocyanic acid. Thus the authors pronounce "a fair sample of the erroneous and bewildering evidence that is frequently offered in courts of justice." But who is to blame if the evidence of unscientific men upon scientific questions is

* *Phil. Trans.*, 1833, 537.

† *Ibid.*, 1839.

offered, and made, as seems here to have been the case, the basis of a hypothesis? This point suggests a lesson to experts. If Mr. Cooper, the chemist engaged on behalf of the prosecution, had been prepared on the spot to say how much hydrocyanic acid was present in apple-pips, this strange suggestion would have been extinguished at once. It will, therefore, be prudent for toxicologists, when they have found any poison in the body of a deceased person, to consider whether such poison can be naturally present in any article of food or drink, and if so, in what quantity? Thus, suppose a case of poisoning by a salt of copper, and it appeared that the deceased had been in the habit of drinking cocoa or chocolate. The expert might save some trouble to himself and some time to the Court, by being prepared to say in what proportion copper naturally occurs in the cacao-bean and in its ordinary commercial preparations.

Another point raised in this case relates to the smell of prussic acid. Mr. Champneys, the surgeon who conducted the autopsy, was positive that he smelt prussic acid on opening the body. When afterwards the contents of the stomach were transferred to a jar, neither the three surgeons nor the analyst, Mr. Cooper, could detect the slightest odour, even on boiling the contents. The authors, therefore, are quite justified in their comments that "All tests involving odour are affected seriously by the remarkable differences between different people as to their sense of smell. We hear much of colour-blindness, but the analogous olfactory defect has almost escaped remark. Yet 'smell-blindness,' as I have formerly christened it, or anozism, if a Greek word be required, is exceedingly common, and chemists and medical men are frequently afflicted with it." Mr. Stewart gives instances from his own observation, of laboratory students who could not smell acetic acid, cyanogen, arseniuretted hydrogen, &c., and of an assistant who was fond of sulphuretted hydrogen!

Fully granting all that the author has said—and more—concerning the absence, the feebleness, the intermittence, and the anomalous character of the sense of smell in many persons, we must take exception to the term "smell blindness." We may venture to give a few suggestions for the benefit of persons who expect to be called upon to give an opinion on the presence, the absence, or the character of some particular odour. They should in the interval abstain from hot liquids, such as tea, coffee, soups, &c., from pungent and irritating condiments, from alcoholic liquors, and from tobacco in any shape. Just before smelling at the object, the mouth should be filled with the coldest water procurable.

In the shape of chemical notes on the Tawell case, there follows an exceedingly useful chapter on hydrocyanic acid, giving its synonyms, its physical and chemical characters, the strengths of its commercial forms; its occurrence in the vegetable world; the preliminary tests in supposed poisoning cases; its salts; its antidotes, medicinal uses, the fatal dose, the symptoms, the *post mortem* appearances, and the systematic procedure for its detection in the body.

Chapter IV.—"Trials for Poisoning by Strychnine"—introduces us to the more recent and still more sensational cases of Palmer and Dove. The former of these cases is pointed out by the authors as specially instructive from "the conflict of the medico-scientific evidence, the most eminent men among our physicians and analysts being called on either side, and the most contradictory testimony as to the possibility of detecting strychnine being given by them." Some persons—ourselves included—strongly question the wisdom of a system which makes the physician, the analyst, or other expert, seem the partisan of the side on behalf of which he is called, instead of, as we submit he should be, the impartial adviser of the Court. The authors, however, if we may argue from a quotation of Mr. Justice Stephen, seem scarcely at one with us on this important point.

Another important point is the necessity of absolute

silence and secrecy towards the public, on the part of the expert, until his report is presented in Court and he is examined thereon. In Palmer's case it would seem that the late Dr. A. S. Taylor, the eminent toxicologist, had approached very closely the limits of indiscretion. It appears that a gentleman on the staff of the *Illustrated Times* had contrived to obtain an introduction to Dr. Taylor. He concealed his connection with the press, and appeared as the representative of an insurance company, and asked for information concerning a number of poisoning cases that had occurred of late years. In consequence, at the trial no inconsiderable part of the cross-examination of Dr. Taylor was occupied by questions connected with the publication in the *Illustrated Times* of this version of the interview. A more serious consequence was that these statements in the *Illustrated Times*, copied into other papers, led Dove to resort to strychnine in order to poison his wife. Our readers will see the moral to be drawn.

The unsatisfactory feature of the trial is that strychnine was not actually found in the body of Cook, though his death took place with symptoms which the medical witnesses could refer to no other cause. It is remarkable that before his execution, whilst not denying that Cook was poisoned, he added, "but not with strychnine."

As in the case of prussic acid, a chapter is devoted to strychnine and brucine, their commercial sources, properties, separation, tests, doses, symptoms, *post mortem* appearances, &c.

The trial of Madeline Smith for poisoning L'Angelier with arsenic is, chemically speaking, of little moment, since the abundant presence of arsenic in the stomach of the deceased could not be contested. Somewhat similar was the case of Dr. Pritchard, condemned for poisoning his wife and his mother-in-law with antimony, aided, as regards the latter, with aconite. Nor need we refer at length to the case of Dr. Smethurst, in which the antagonism between Mr. Herapath and Dr. Taylor broke out in a somewhat irregular manner. The authors remark that "Taylor's tests both for arsenic and antimony were not reliable."

Lastly comes poisoning by aconitine, as illustrated in the recent case of Lamson. Aconitine, having no very striking chemical reactions, the evidence of the poison was mainly obtained by the experiments performed by Dr. T. Stevenson upon himself and upon a few mice. It is a curious fact, as showing the inconsistency of the public mind, that though thousands of mice are weekly destroyed by poisons more or less rapid, by traps, and by cats, without the least comment, yet the sacrifice of these few specimens for an important purpose called up no small displeasure. On this subject it is to be noted that counsel for the defence misquoted Dr. Tidy, and ascribed importance to a dictum of Lord Coleridge, whose opinions, on a physiological or chemical question, are about as valuable as would be our own on a point of law.

We must here close our survey of this work by pronouncing it henceforth indispensable to all chemists who practise in toxicology, of great value to the medical profession generally, and doubtless no less so to solicitors and counsel who may be concerned in poisoning cases.

The index is scarcely as complete as the nature of the work requires.

Reproduction of Albite in the Moist Way.—C. Friedel and E. Sarasin.—By the reaction of potassium and aluminium silicates at an elevated temperature in presence of water, the authors have obtained orthose in a crystalline powder capable of being microscopically determined. On proceeding in a similar manner with sodium and aluminium silicates in proportions representing the composition of albite, they obtained analcime, and finally, by adding to the above mixture a further quantity of sodium silicate and heating to about 500°, they produced albite in distinct crystals.—*Comptes Rendus*.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvi., No. 5, July 30, 1883.

Separations of Gallium.—Lecoq de Boisbaudran.—Will be inserted in full.

Critical Temperature and Critical Pressure of Oxygen.—S. Wroblewski.—The temperature in question is about -113° , and the pressure 50 atmospheres.

Determination of the Internal Inert Resistance of any Electric System whatever, notwithstanding the Perturbing Actions of its Internal Electromotive Forces, unknown as to Number, Situation, and Magnitude.—G. Cabanellas.—A mathematical paper, not adapted for useful abstraction.

Visibility of the Ultra-Violet Rays.—J. L. Soret.—There is a region of the spectrum, extending to beyond the ray Q, composed of rays which are not notably absorbed by the media of the eye, and for which the sensibility of the retina is much inferior to that obtained with the fluorescent eye-piece.

Crystalline Calcium Phosphate produced during the Dephosphorisation of Cast-iron.—MM. A. Carnot and Richard.—These crystals were found in the cavities of slags obtained from the iron works of Jœuf. Their composition and their crystalline form are described.

Artificial Production of Rhodonite and Tephroite.—Alex. Gorgeu.—The author's method is founded on the reciprocal action of silica and manganese chloride at a red heat in presence of watery vapour. He considers that this may be the method in which these compounds have been produced in nature.

Menthyl Chloride.—G. Arth.—The author concludes that Oppenheim's menthyl chloride and his own menthene hydrochlorate are identical. The same fact has been already demonstrated by Kachler and Spitzer for borneol chloride and camphene hydrochlorate.

Acid Products from the Bacterian Fermentation of the Albumenoid.—Arm. Gautier and A. Etard.—The authors have obtained the following acids from the products of this fermentation:—The formic, acetic, butyric, valeric, and palmitic; the acrylic and crotonic; the glycolic, lactic, and valero-lactic; the oxalic, succinic, and carbonic; and lastly, of nitrogenous acids, $C_9H_{15}NO_4$, the amido-stearic, besides leucines and leucines.

An Isomer of Laurene.—A. Renard.—The product in question is a light oil, not attacked by ordinary sulphuric acid, and boiling at from 193° to 195° .

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome x., June, 1883.

The Colouring-Matters of Madder and their Metamorphoses.—A. Rosenstiehl.—The author gives a description of the colouring-matters obtained from madder, *i.e.*, alizarin, purpurin, hydrated purpurin, pseudo-purpurin, purpuro-xanthin, and munjistin. He remarks that pseudo-purpurin cannot exist in any extract or other commercial extract of madder which has undergone the action of hot water, such as garancin. It is only found in madder, fleur de garance, madder lake, and the commercial purpurin of Emile Kopp. The quantity of madder raised in the Vaucluse and Holland amounted to about 35 million kilos. yearly in the period 1859 to 1863. During 1870-71 it fell momentarily to 17 millions, and rose again immediately to its maximum 30 millions (?). From 1874 the increasing influence of artificial alizarin

made itself felt, and in 1878 the yield of the Vaucluse was only 2 million kilos., and that of Holland 600,000. It then ceased in Vaucluse, where it is in effect abandoned, as also in Alsace, where, however, artificial data are wanting. At present madder is cultivated in Holland alone. In 1881 the production was 600,000 kilos., and 1,200,000 in 1882. The firms who manufactured the extract of madder have, substantially, ceased their operations. The industry created by Emile Kopp, however (pseudo-purpurin), still exists, producing an article which chemistry cannot obtain synthetically. Pseudo-purpurin has its special uses; in calico-printing it yields a very fine rose, which bears sunlight very well, though not soaping, and in the manufacture of pigments it is utilised as a valuable red lake.

Journal de Pharmacie et de Chemie.
Tome viii., August, 1883.

Examination made by M. J. L. Soubeiran of a Thesis by M. Francois Gay on the "Micrographic and Spectroscopic Study of Tinctures and Alcohols."—For making the microscopic examination of a tincture, the author brings it to such a consistence that the alkaloids present may crystallise. In spectroscopic investigation the author divides tinctures into those which do not give the spectrum of chlorophyll and those which do. The former group are sub-divided into those with continuous spectra and those showing absorption-bands.

Prolonged Anæsthesia obtained by Means of Nitrogen Protoxide at the Normal Pressure.—Paul Bert.—From the *Comptes Rendus*.

Action of Mixtures of Air and of the Vapour of Chloroform, and a New Process of Anæsthesia.—Paul Bert.—From the *Comptes Rendus*.

The Use of Ether and Chloroform in detecting Salicylic Acid in Wines.—R. Malenfant.—The author recommends chloroform as preferable to ether. He measures into a bottle 50 c.c. of the wine to be analysed and 20 c.c. of pure chloroform. The mixture is moderately shaken so as not to emulsify the chloroform too completely, thrown into a funnel with a ground glass cock, and let settle. After a few minutes the mixture separates into two layers, the chloroform at the bottom. About 10 c.c. are drawn off into a test-tube, and shaken up with a drop of ferric chloride and some c.c. of water. If salicylic acid is present the characteristic violet colour appears in the watery stratum which floats above the chloroform.

The Action of Wines with Polarised Light.—S. Cotton.—M. Girard states that "piquettes" made from raisins turn the plane of polarisation to the left, while natural wines turn it to the right. The author finds that wine made from the grapes of an American vine (variety, Jacquez), gives a deviation to the left of -5° .

Alumed Wines.—M. Malenfant.—The author incinerates 100 c.c. of the wine in a platinum capsule, boils the ash repeatedly with soda-lye at 36° (B. ?), passes through a Berzelius filter, adds to the liquid a little sal-ammoniac in solution, heats for a few minutes, collects the alumina on a filter, washes, ignites, burns the filter, and weighs.

Evonymine, its Properties and its Preparation.—Paul Thibault.—A pharmaceutical memoir.

An Organism which is developed in the Solutions of Calcium Diphosphate.—M. Royer.—The flocks suspended in the solution take the form of a yellowish mass, formed of elongated branching filaments. The plant in question is a Schizomycetic protophyte belonging to the genus *Hygrocrocis*.

Action of the Liquids of the Digestive Canal upon the Antimonial Compounds.—L. Garnier.—The hydrochloric acid of the gastric juice and the neutral salts (chlorides) of all the intestinal secretions have only a very

feeble action upon the derivatives of antimony. The organic acids and the alkalies dissolve them in considerable quantity.

Rapid Method for the Assay of Potassium Iodide.—M. Herbelin.—The author's process is based upon the fact that 332 parts of the iodide, in contact with 135.50 of mercuric iodide gives a colourless solution if the iodide is pure. As such absolute purity does not exist and is not required, a remedy of 5 per cent is allowed; thus reducing the figure 135.50 to 128.72. The author proceeds as follows:—Weigh out exactly 1 grm. of the sample, and dissolve it in 30 c.c. of water. These proportions correspond to 33.20 per litre. Measure with a drop-counter 20 drops of this solution into a glass. Add to this liquid with a drop-counter like the former, a solution containing 13.55 grms. mercuric chloride per litre, until a colouration appears. If the iodide is chemically pure 20 drops will be needed. If it contains 5 or 10 per cent of impurities, 19 or 18 drops will be respectively required.

Preparation of Hydrobromic Acid.—M. Gruning.—The author decomposes potassium or sodium bromide with phosphoric acid at a boiling heat. The specific gravity of the phosphoric acid employed is 1.304.

Cafeine and its Salts.—H. Biedermann.—An account of cafeine hydrochlorate, hydrobromate, hydriodate, nitrate, sulphate, auro-chloride, platino-chloride, formiate, acetate, butyrate, and valerianate.

Phosphorescence of Sulphur.—K. Heumann.—If sulphur is heated on a plate of metal or porcelain, its vapours, in the dark, give off a phosphorescent light. The flame is pale, scarcely bluish, very different from the fine blue flame given by the combustion of sulphur at higher temperatures. In place of sulphurous acid gas the phosphorescent sulphur emits vapours having an odour which recalls at once that of hydrogen bisulphide, of camphor, and ozone.

Biedermann's Central-Blatt für Agrikultur-Chemie,
Vol. xii., Part 6.

Experiments on the Dialysis of Arable Soil.—Prof. A. Petermann.—The author, on submitting various specimens of earth to dialysis, finds that arable soils give up to water, from which they are separated by parchment-paper, the following constituents of plant-food:—Lime, magnesia, iron, potassa, soda, sulphuric, phosphoric, and nitric acids, silica, and chlorine. Ammonia, though present in the soils, could not be detected in the water, even by Nessler's reagent, and is probably oxidised to nitric acid. Soils contain organic matter which readily diffuses through parchment-paper.

Influence of Manuring upon the Composition of Potatoes.—Profs. Märcker, Graeger, and Vibrano-Calvörde.—The use of soda-saltpetre increased the gross weight of the crop, but the total dry matter was decreased; the starch was diminished by 6 per cent, but the albumenoids were increased.

Influence of Early or Late Manuring with Kainite upon the Proportion of Starch in Potatoes.—Dr. M. Fleischer.—The use of potash favours the gross yield, upon which the time of its application seems to have no influence. As regards the proportion of starch, a kainite dressing in autumn is most favourable.

Manurial Value of Peat used as a Layer for Cattle.—Dr. M. Fleischer.—The fibrous peat of Silesia and Wurtemberg has a higher manurial value than the moss-turf of North Germany.

Manurial Experiments on Rye and Wheat in the Province of Saxony.—Prof. M. Maercker.—The author concludes that the use of phosphates alone does not increase the crop, even in superior sandy soils. Phosphate in conjunction with nitrogen is, however, to be strongly

recommended. Steamed bones are the best form of phosphate for sandy soils.

Use of Artificial Fertilising Agents in the Cultivation of Potatoes.—S. Guradze.—The author gives a favourable report of the effects of the recently-patented "potash-magnesia," containing 50 per cent potassium sulphate and 34 per cent magnesium sulphate.

Manuring Sugar-Beets.—Prof. Holdeffleiss.—The author recommends the moderate use of farmyard manure, aided by soda-saltpetre.

Manurial Experiments in the Vineyards of the Ahr Valley.—Dr. A. Stützer.—An artificial manure containing 7 per cent soluble phosphoric acid, 6 per cent potash, and $2\frac{1}{2}$ to 3 of nitrogen, gave 20 per cent more grapes than farmyard manure. The above-mentioned mixture gave also the highest proportion of sugar and the lowest of acid.

Influence of the Electric Light upon the Development of Plants.—P. P. Deherain.—The author shows that the electric light contains rays harmful to vegetation, which, however, are chiefly held back by transparent glass. It contains enough of the rays useful to vegetation to maintain the life of plants under its sole influence for two months and a half. The quantity of favourable rays is too small to ripen crops.

Moniteur Scientifique, Quesneville.
August, 1883.

This number contains merely a translation of Professor Hofmann's biography of the late F. Wöhler; a verbatim report of the discussion in the Chamber of Deputies on the proposed increase of the pension awarded to M. Pasteur; and the usual report of the proceedings of the Academy of Sciences.

Justus Liebig's Annalen der Chemie,
Band 219, Part 1.

Vulpianic Acid.—Adolf Spiegel.—The author has discovered a new compound, pulvinic acid, from which vulpinic acid may be considered as derived. To this new acid he assigns the formula $C_{18}H_{12}O_5$, vulpinic acid being $C_{19}H_{14}O_5$. In the present memoir he discusses in succession the direct derivatives of pulvinic acid, its reduction products, its oxidation, oxytolylic acid, and the constitution of pulvinic and vulpinic acids.

Communications from the Chemical Laboratory of the University of Jena.—These consists of a paper by A. Geuther on the yellow and red oxides of lead; a memoir by Dr. W. Wedel on certain derivatives of acetacetic ester (ethyl-diacetic acid); and a paper by A. Geuther on the constitution of acet-acetic ether, and on that of benzol.

Cosmos les Mondes.

Tome v., No. 12, July 21, 1883.

Combination-Heats of the Soluble Compounds of Lithium.—Dr. D. Tommasi.—The author gives the comparative combination-heats of lithium sulphide as calculated and determined experimentally, and furnishes also a table of the calculated heats of the principal lithium compounds.

No. 13, July 28, 1883.

The Use of Cadmium Tungsto-borate for the Mechanical Analysis of Rocks.—D. Klein.—The sp. gr. of this solution is 3.281, and it consequently permits of the mechanical separation of a number of metals.

ERRATA.—P. 7, col. 1, for "scarifier" read "scorifier"; line 9 from bottom, for "test" read "rest." P. 8, col. 1, under "Grms. $Mg_2As_2O_7$," for "0.0671" and "0.0671" read "0.0762" and "0.0761"; col. 2, line 27 from top, for "0.2" read "0.25"; line 41 from top, for "two" read "four." P. 9, col. 1, under "Grms. Ore," for "0.2" read "0.1" in each case.

THE LONDON HOSPITAL and MEDICAL COLLEGE, MILE END, E.—The SESSION 1883-4 will commence on Monday, October 1st, 1883, when the Prizes for the past Session will be distributed, after which there will be a Conversation, to which all past and present students are invited. **FOUR ENTRANCE SCHOLARSHIPS**, value £60, £40, £30, and £20, will be offered for competition at the end of September to new Students. Fees for Lectures and Hospital Practice, 90 guineas in one payment, or 100 guineas in three instalments. All resident and other Hospital appointments are free. The resident appointments consist of Five House Physiciancies, Five House Surgeoncies, and One Accoucheurship; Two Dressers and Two Maternity Pupils also reside in the Hospital. Special entries may be made for Medical and Surgical Practice. The London Hospital is now in direct communication by rail and tram with all parts of the metropolis.

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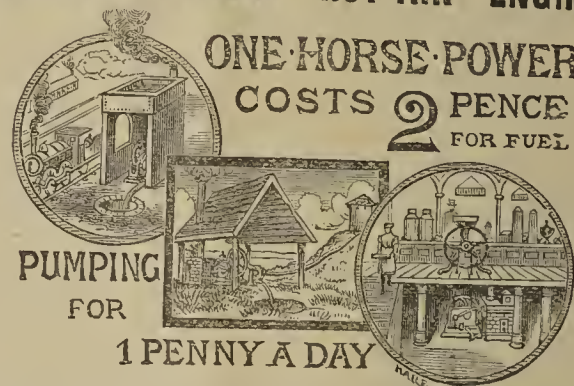
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THE CHEMICAL NEWS.

VOL. XLVIII. No. 1239.

VOLUMETRIC METHOD FOR ESTIMATING ARSENIC.

By ALBERT H. LOW.

IN the CHEMICAL NEWS of July 6, 1883, appeared an article by Leroy W. McCay on "A New Volumetric Method for Estimating Arsenic," in which a paper on the same subject lately read before the Colorado Scientific Society by Mr. Richard Pearce was referred to and criticised. I will endeavour to show that this criticism was unsound.

Mr. Pearce's method depends upon the insolubility of arseniate of silver under certain conditions. These conditions are attained as follows:—A fusion of the arsenic compound is made with carbonate of sodium and nitrate of potassium. The soluble portion is afterward extracted with water and filtered. The filtrate is acidified with nitric acid and boiled. It is then cooled and almost exactly neutralised with ammonia, leaving, however, a slight alkaline reaction. These are the conditions. A neutral solution of nitrate of silver is now added in slight excess which precipitates the arsenic as arseniate of silver.

The following is Mr. McCay's criticism on the above:—"Silver oxide is precipitated by ammonium hydroxide from a neutral solution of a silver salt, and it is only upon the addition of an excess of the alkali that the precipitate can again be brought into solution. The question now arises, is there not danger of precipitating some silver along with the arsenic? If so will this not serve to vitiate the method? To settle the matter, I took about 2½ c.c. of a strong solution of silver nitrate, diluted with water to about 50 c.c., and after heating to boiling, added a drop of dilute ammonium hydroxide solution—no precipitate; two drops, no precipitate; three drops, no precipitate; twelve drops, none.

The solution was next tested with litmus paper, but showed absolutely no alkaline reaction. When the ammonia was allowed to run in until the resulting reaction was faintly alkaline, a distinct cloud, due to the formation of silver oxide, made its appearance. This cloud, by permitting the solution to stand for some time, became larger and larger, but soon reached a maximum. In opposition, therefore, to Pearce and Lov, I declare that the solution immediately prior to precipitation dare not be alkaline! Now it will be observed that the result on which the criticism is based is obtained under conditions quite different from those of Mr. Pearce's method. The most important difference is in the comparative amount of nitrate of ammonium present. By Mr. Pearce's method there is always a considerable excess of nitrate of ammonium, in which oxide of silver is sufficiently soluble, and but very little oxide of silver to be dissolved by it, as only so much is liberated as corresponds to the amount of free ammonia present, while in Mr. McCay's experiment the small amount of nitrate of ammonium formed is surcharged with oxide of silver, which finally begins to precipitate.

If at this point Mr. McCay had added a few crystals of nitrate of ammonium he would have seen the precipitated oxide of silver immediately disappear. Or, if he had previously dissolved a little nitrate of ammonium in the silver solution he would have obtained no precipitate at all with ammonia. This point was carefully tested before Mr. Pearce's method was made public. The direction to have the solution slightly alkaline instead of perfectly neutral was given advisedly, as it was found that a perfectly neutral

* At the time this method was worked out Mr. Pearce had not heard of Reich and Richter's process,

solution containing much arsenic (as alkaline arseniate obtained by fusion), became decidedly acid on the addition of a neutral solution of nitrate of silver,* a fact that has apparently escaped Mr. McCay's observation. By making the solution slightly alkaline to start with the tendency to become acid is usually sufficiently neutralised when only a small amount of arsenic is present. The filtrate is always tested, and if found too acid it is carefully neutralised and re-filtered. In practice this is rarely necessary on account of the small quantity of substance taken for analysis. I seldom find any arsenic in the filtrate and when I do it occasions but very little delay to filter it through the original filter (from which the bulk of the arseniate of silver has previously been dissolved) and then wash it with acid into the main portion. The method was originally intended simply as a rapid and sufficiently accurate process for estimating arsenic in copper ores and furnace products, but an almost daily use for over six months has convinced me that it possesses great reliability and accuracy. I have not had an instance where the disagreement between duplicates exceeded one-tenth of a per cent. This could not be the case were the above criticism well founded. I see no advantage as regards either time or accuracy in Mr. McCay's modification of the process. In fact I consider the plan of dissolving the precipitated arseniate of silver in dilute nitric acid and titrating for the silver better than that of Mr. McCay, in which the excess of silver, remaining after precipitation of the arseniate, is determined, on account of the great liability of the reagents to contain chlorine. While this impurity would not affect Mr. Pearce's process it would cause the results by Mr. McCay's method to come low.

Regarding the proper treatment of sulphide of arsenic, which Mr. McCay is "endeavouring to discover," I will say that if after oxidising with fuming nitric acid he will evaporate to dryness and then make the usual fusion with the residue, he will have no further trouble. When the amount of sulphide has been small I have obtained perfectly satisfactory results by fusing directly without previous oxidation.

I trust the above explanations are sufficiently clear to remove all doubt from Mr. McCay's mind relative to the reliability of Mr. Pearce's process; if not, I shall be happy to give any further details he may require.

Argo, Colo., July 30, 1883.

I subjoin the following published description of Mr. Pearce's process, observing, however, that a platinum crucible is much better than one of porcelain. After the fusion it can be cooled at once in water, thus saving much time, and it appears to be but very slightly acted upon. I have used one in a large number of determinations with ores and furnace products containing high percentages of arsenic, copper, lead, and sulphur, and it remains apparently uninjured.

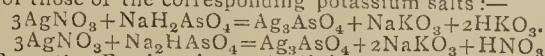
The Estimation of Arsenic.†

By O. J. FROST, Argo, Colo.

MR. Richard Pearce, of the Boston and Colorado Smelting Company, Argo, Colo., has long felt the need of a rapid and reliable method for the estimation of arsenic in ores and metallurgical products, and more particularly in copper ores and copper smelting products. After a great many experiments in different directions, the following scheme, depending upon the insolubility, under certain conditions, of silver arseniate in neutral solutions, has been found to work well. It was described by him in a paper read before the Colorado Scientific Society.

The finely-powdered substance for analysis is mixed in a large porcelain crucible with from six to ten times its weight of a mixture of equal parts of carbonate of sodium and nitrate of potassium. The mass is then

* Presumably in accordance with one or both of the following reactions or those of the corresponding potassium salts:—



† From the *Engineering and Mining Journal*.

heated with a gradually increasing temperature to fusion, and kept for a few minutes in that state. It is then allowed to cool, and the soluble portion is extracted by warming with water in the crucible, and filtering from the insoluble residue when disintegration is complete. The arsenic is in the filtrate as alkaline arseniate. The solution is acidified with nitric acid and boiled to expel carbonic acid and nitrous fumes. It is then cooled to the ordinary temperature, and almost exactly neutralised as follows:—Place a small piece of litmus-paper in the liquid: it should show an acid reaction. Now gradually add strong ammonia till the litmus turns blue, avoiding a great excess. Again make slightly acid with a drop or two of strong nitric acid; and then, by means of very dilute ammonia and nitric acid, added drop by drop, bring the solution to such a condition that the litmus-paper, after having previously been reddened, will, in the course of a half a minute, begin to show signs of alkalinity. The litmus-paper may now be removed and washed, and the solution, if tolerably clear, is ready for the addition of nitrate of silver. If the neutralisation has caused much of a precipitate (alumina, &c.), it is best to filter it off at once, to render the subsequent filtration and washing of the arseniate of silver easier.

A solution of nitrate of silver (of neutral reaction) is now added in slight excess; and after stirring a moment, to partially coagulate the precipitated arseniate, which is of a brick-red colour, the liquid is filtered, and the precipitate is washed with cold water. The filtrate is then tested with nitrate of silver and dilute nitric acid ammonia, to see that the precipitation is complete.

The object is now to determine the amount of silver in the precipitated arseniate of silver, and from this to calculate the arsenic. Two methods may be employed, the conveniences of a laboratory determining which is preferable: (1) The arseniate of silver may be subjected to scorification (or fusion) and subsequent cupellation. This necessitates the removal, earlier in the process, of any soluble chloride present. (2) The arseniate of silver may be dissolved on the filter with dilute nitric acid (which leaves undissolved any chloride of silver), and the filtrate titrated, after the addition of ferric nitrate or sulphate, with sulphocyanate of ammonium. About five cubic centimetres of a saturated solution of ferric-ammonio-sulphate are added, and the standardised sulphocyanate solution (about 5 grms. to the litre) run in until a faint red tinge is obtained, which remains after considerable shaking. The shaking breaks up the clots of sulphocyanate of silver and frees any solution held mechanically.

From the formula $3\text{Ag}_2\text{O}.\text{As}_2\text{O}_5$, we deduce 648 parts $\text{Ag} = 150$ parts As , or $\text{Ag} : \text{As} = 108 : 25$:

	As Per cent.
1-10 of a gm. of a sample enargite tested by this method gave	19'030
A second trial showed	19'090
To try the effect of antimony, 1-10 of a gm. of the enargite was mixed with an equal weight of stibnite and tested: the result was	19'130
The arsenic in the enargite determined by the arseniate of magnesia and ammonia method showed	19'440
A sample of copper glance was tested, and found free from arsenic. This was then added in sufficient quantity to the enargite to produce a mixture calculated to contain..	0'370
0'55 gm. was taken for analysis and showed..	0'380
A test on 1-20 of a gm. of pure proustite gave	15'080
Theoretical	15'150
A sample of copper matte gave first trial	0'470
Second trial	0'460
Another sample of copper matte gave, on first trial	0'280
Second trial	0'284
A sample "pimple" metal gave	0'458
Repeated	0'459

Additional experiments have been equally satisfactory.

This method for the estimation of arsenic is not only accurate, it is short also. By process (2) an estimation can easily be made in half an hour; and an estimation has been made by Mr. A. H. Low in the Laboratory of the Boston and Colorado Smelting Company at Argo, where the details of the process were worked out in twenty-two minutes.

Owing to the large amount of arseniate of silver formed from a small quantity of arsenic (nearly six times by weight), it is not at all necessary or even desirable to work with large amounts of substance. Half a gm. is usually sufficient for the determination of the smallest quantity of arsenic; and where the percentage is high, as little as one-tenth or one-twentieth of a gm. may be taken with advantage. The method has been used with very satisfactory results on the sulphide of arsenic obtained in the ordinary course of analysis.

Substances such as molybdic and phosphoric acids, which may behave similarly to arsenic under this treatment, interfere, of course, with the method. Antimony, by forming antimoniate of sodium, remains practically insoluble and without effect.

It is quite probable that the method could be adapted for the rapid estimation of phosphorus in commercial products and in iron and steel; but beyond a few preliminary experiments, nothing has been attempted in this direction.

SEPARATION OF GALLIUM FROM VANADIUM.

By M. LECOQ DE BOISBAUDRAN.

THE author has only found a single process which if used alone enables us to effect this analysis with accuracy. We may succeed, however, very well by combining several methods, as will be explained below.

1. The hydrochloric solution, slightly acid, is mixed with arsenious acid and an excess of acid ammonium acetate, and is then treated with a current of sulphuretted hydrogen. Under these circumstances the vanadium is not precipitated. The galliferous arsenic sulphide, previously washed in water containing a little acid ammonium acetate and sulphuretted hydrogen, is treated with aqua regia. The arsenic acid is reduced by sulphurous acid, and sulphuretted hydrogen is passed into the strongly acid hydrochloric solution. The arsenic sulphide no longer contains any gallium, and the latter may be obtained by evaporating the filtrate. This process is especially advantageous for extracting traces of gallium mixed with large quantities of vanadium compounds.

2. The hydrochloric solution of the vanadic or vanadous compound containing gallium is neutralised almost entirely with ammonia, and an excess of ammonium sulphide is added drop by drop, stirring all the time. A decided excess of hydrochloric acid is then added drop by drop, still stirring. There is thus precipitated vanadyl sulphide, which is received upon a filter and washed with very dilute hydrochloric acid containing hydrogen sulphide. The clear liquid is boiled with aqua regia in order to destroy the ammoniacal salts and to diminish the bulk: the last traces of nitric acid are expelled, and the liquid is treated as above. After six or seven similar operations only a very small quantity of vanadium remains with the gallium chloride. As for the vanadyl sulphides obtained, they retain traces of gallium, which are separated by dissolving in aqua regia and re-commencing the series of treatments with ammonium sulphide and dilute hydrochloric acid. This process is long, and little applicable except in certain particular cases.

3. The hydrochloric solution of the galliferous vanadic or vanadous compound is supersaturated with ammonia, and boiled until a piece of litmus-paper placed in the liquid begins to turn red. The boiling must not be carried further, in order to prevent the formation of acid ammonium vanadate (of a yellow colour), which seems to

dissolve a small quantity of gallium oxide. It sometimes happens that the boiled solution remains of a deep green. In this case a few drops of ammonia are added, and the boiling is repeated when the liquid becomes colourless. In spite of every precaution the filtrates, rich in vanadium, retain traces of gallium, which though small cannot be neglected. The gallium oxide also carries with it vanadium; it is therefore re-dissolved in hydrochloric acid, and the boiling with ammonia is repeated a second time, but without thus effecting the entire removal of the vanadium. This process serves merely for obtaining expeditiously on the one hand a solution containing the great bulk of the vanadium with traces of gallium, and on the other, a precipitate containing almost all the gallium with a small quantity of vanadium.

4. The mixture of salts of gallium and of vanadic or vanadious compounds is mixed with sulphuric acid and ammonium sulphate in proportions suitable for forming ammoniacal-gallial alum. The operation is conducted as described in *Comptes Rendus*, 1883, p. 143. After two or three re-crystallisations the alum is free from vanadium, but a small quantity of gallium remains in the solution of vanadium.

In an accurate analysis the author proceeds as follows in the three cases given,—the only ones which can occur:—

A. Much vanadium and very little gallium. The process No. 1 must be used.

B. Very little vanadium and much gallium. The larger portion of the gallium is removed by process No. 4, and the residual liquid comes under case C.

C. Both gallium and vanadium are present in considerable quantities. We commence with two successive boilings with ammonia (process No. 3), which gives vanadiferous gallium oxide and a solution rich in vanadium and very poor in gallium. This solution is treated as under case A. The vanadiferous gallium is transformed into alum free from vanadium. The mother-liquors, when boiled with ammonia, furnish a vanadic liquid very poor in gallium (to be added to A), and a small quantity of vanadiferous gallium oxide, from which a little pure gallium alum is extracted. When the mass is become too small to permit of the preparation of alum, it is added to the liquids A, which are freed from gallium by the arsenic sulphide process (No. 1).—*Comptes Rendus*.

ON THE EXAMINATION OF FATS.

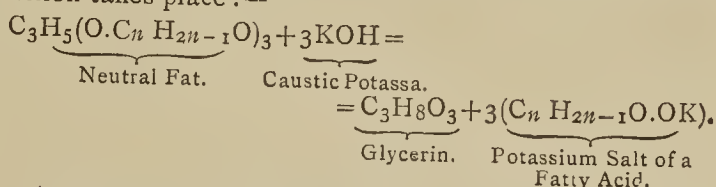
By K. ZULKOWSKY.

SOME time ago Max Gröger submitted Hausemann's method of titration for mixtures of neutral fats and fatty acids to a thorough examination in the author's laboratory. He has succeeded in improving and simplifying the method to such an extent that it is now easier to determine such a fatty mixture than a mixture of caustic soda and sodium carbonate. The method is based upon the fact that a fatty acid in an alcoholic solution is immediately saponified by an alcoholic solution of potassa, whilst with neutral fats this change ensues only on prolonged boiling. If we therefore add phenol-phthaleine to the alcoholic solution of fatty acids and neutral fats, and titrate with caustic potassa, the red colour disappears instantly as long as free fatty acids are present. When these are saturated the liquid turns red. If an excess of solution of caustic potassa is added and the liquid is boiled for half an hour, the neutral fat is saponified, and on titrating back we find the volume of the potassa solution which has been required for saponifying the neutral fat. From the consumption of this test-liquid in the saponification of the fatty acids and of the neutral fats, their quantity can be calculated, even if the weight of the mixture is not known. This is the principle of this simple and elegant method, which, according to test-experiments, yields very accurate results.

On further consideration the author regards Hausemann's idea as a mine from which may be obtained much that will be useful in the technology of fatty matters. Several cases follow in which it gives exceedingly valuable conclusions in testing fats.

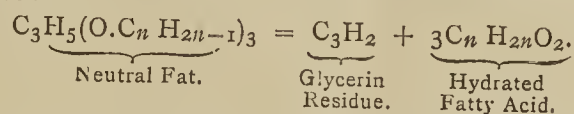
1. It is possible to ascertain the equivalent of a fat, *i.e.*, the quantity of it which is saponified by an equivalent of caustic potassa, or by a litre of normal potassa. This figure gives in certain cases an indication concerning the nature of the fats. In the examination of butters the equivalent will beyond doubt show whether we have to do with a natural or a factitious butter. Whether it will be possible to detect a mixture of both with certainty must be decided by future experiments.

2. We are enabled to determine directly and in the simplest possible manner the proportion of glycerin in fats, *i.e.*, the theoretical yield of glycerin. In titrating a neutral fat or a mixture of several fats, the following reaction takes place:—



According to this equation, for every litre of normal potassa $\frac{1}{3}$ rd of an equivalent, *i.e.*, 30.667 grms., of glycerin will be liberated, or 1 c.c. normal alkali represents 0.030667 gm. glycerin. The determination of the proportion of glycerin in fats is at present of great technical interest, as in consequence of the growing demand and the high market price the yield of glycerin cannot be left out of consideration.

3. When the proportion of glycerin has thus been established by titration if the fat is pure and free from water, the theoretical yield of fatty acids appears at once. The tri-glycerides can be regarded as decomposed as follows:—



If we compare this equation with the former one, 1 litre normal alkali corresponds to $\frac{1}{3}$ equivalent, *i.e.*, 12.667 of the glycerin residue, C_3H_2 . If v c.c. normal alkali have been consumed, the weight of the glycerin residue ($0.012667 v$) = G, and if F grms. of the neutral fat have been weighed out (F - G) is the quantity of the fatty acids.

4. If the proportion of fatty acid (F - G) has been thus determined their equivalent follows. If we have used v c.c. normal alkali the equivalent results from the following proportion:—

$$\begin{array}{l} (F - G) : A = v : 1000. \\ A = \frac{1000 (F - G)}{v}. \end{array}$$

—*Berichte Deutsch. Chem. Gesell.*

NOTES ON THE METALLURGY OF NICKEL IN THE UNITED STATES.*

By WILLIAM P. BLAKE, F.G.S., New Haven, Conn.

THE metallic element Nickel, discovered by Cronstedt, the mineralogist, in the year 1751, as a peculiar metal in kupfer-nickel, remained for a long time comparatively unknown in its true characters. It was at first obtained as a secondary or by-product, in the manufacture of extraction of cobalt, being found concentrated in the cobalt speiss left in the pots when smalt or cobalt-blue glass was manufactured. Cobalt at that time was the product chiefly sought, and nickel in its applications was unknown.

* Read at the Boston Meeting of the American Institute of Mining Engineers, Feb., 1883.

Since the discovery of the artificial ultramarine blue, the demand for cobalt has been lessened, while the increasing uses of nickel have made it of first importance, and the conditions are thus reversed.*

But the nickel so reduced from the residues was contaminated with copper, iron, or arsenic, and in this condition it entered into the composition of the familiar alloy commonly known as German silver, but properly known as nickel silver.

The so-called nickel or nickel bronze was a complex, irregularly constituted alloy, in which less than one per cent of arsenic was sufficient to greatly modify its physical properties. And it was difficult to free the metal from this element. It may be said that until within a few years, the element nickel, in its true characters and in a comparatively pure condition, was commercially unknown.

To the scientific chemists, however, its true physical properties early became known, though not without some contradictory and varying results, at first, resulting no doubt from minute differences of composition of their samples according to the nature of the processes employed for the extraction of the metal. Richter found that nickel oxide strongly ignited in an earthen crucible with carbon, gave the metal in a perfectly malleable, ductile condition. It could be hammered cold or hot into plates 1-tooth of an inch in thickness, and could be drawn into wire 1-56th of an inch in diameter.† Its malleability was found to be diminished by carbon or manganese. On the other hand, Tupputi found that nickel reduced in the presence of carbon in a covered charcoal crucible and under glass, formed more or less nickel-graphite, absorbed a portion of carbon, and was less ductile than zinc. It was brittle when cold, and was as fusible as cast-iron (Erdmann), while the metal obtained by Richter was difficult of fusion. He also noted that nickel could be welded, but Tourte found that it welded but imperfectly.

Déville cited cobalt and nickel as metals with useful physical properties but little known, such as malleability, ductility, and a tenacity surpassing that of iron. He showed that these metals could be worked at a forge with the same facility as iron; that they were susceptible of being employed in the same manner and were less oxidisable.‡

Inasmuch as nickel first became known commercially in the industrial arts in the form of an alloy, there were no special attempts to produce the metal in a state of extreme purity. The nickel silver of commerce answered all the existing demands, and was of course much easier to make, and cheaper than the pure nickel. It found a large and rapidly extending consumption as a substitute for silver spoons and forks and for silverware generally, especially when the new art of electro-plating was developed by Spencer, Smee, and others. The nickel silver was specially well adapted to receive and hold the deposit of silver, and it is to this day the most desirable alloy for plating.

The use of nickel alloy for small or subsidiary coins next made an increased demand for nickel. Tentative efforts were made by Dr. Feuchtwanger, in New York, in the year 1837, and he actually issued many small one-cent and three-cent pieces, made of a nickel alloy, the exact composition of which he was careful not to state, but called it "Feuchtwanger's composition." Switzerland commenced using nickel alloy coins in 1850; the United States in 1857, though sample coins, one-cent pieces, had been made by Professor James C. Booth, at Philadelphia, in 1853, the prepared alloy containing from 5 of nickel and 95 of copper, to as high as 30 of nickel, and 70 of copper. The alloy adopted by law consisted of 12 of nickel and 88 of copper. The five-cent pieces now in circulation are made of an alloy of 25 parts of nickel and 75 parts of copper. In 1860, Belgium adopted an alloy of the same proportions, for small coins.

Other countries have followed, until the use of nickel alloy for small coins may be said to be almost universal in the chief commercial countries. Up to June 30th, 1876, the United States had alone issued of the five-cent nickel to the extent of 6,716,129 dols. in value. Another sudden demand for a larger supply of nickel sprung up when the art of depositing nickel by electricity was perfected. The many and increasing applications of this art need not be here enumerated. It is sufficient to state that at the present time, they constitute a large part of the present consumption of the metal in this country, where the art may be said to have originated in a successful, practical form.

Nickel ore is more generally distributed throughout the mineral-bearing portions of the United States than is generally supposed. It is commonly associated with chrome ores from Canada to Maryland, on the Atlantic side, and equally with the chrome ores of the Pacific slope, notably in Oregon. It is also a common associate of magnetic pyrites in the Archæan rocks, being found in Litchfield county, in Connecticut; in the Highlands of the Hudson, in New York, and in New Jersey; and especially at Lancaster Gap, in Pennsylvania, where the chief supply of nickel has been obtained for the United States. This ore yields from 1½ to 2 per cent of nickel, but is enriched by smelting at the mine into a matte containing 10 per cent or more of the metal. This locality was worked some thirty years ago by Prof. James C. Booth and others, of Philadelphia, and some nickel alloy was made. Some ten years later Mr. Joseph Wharton purchased the works and established the industry at Camden, N.J., opposite Philadelphia, where it has since been carried forward.

A large portion of the metal produced at these works by Mr. Wharton has been used at the United States mint for the subsidiary small coins, and a considerable amount has been exported. Since the development of nickelling by galvanism, a large part of the product has been put into the form of nickel salts and anodes.

But Mr. Wharton not being content with the production of impure nickel, early commenced experimenting to determine whether nickel could not be produced in a pure and malleable condition, susceptible of being worked in nearly the same manner as iron, and of being applied in the manufacture of various objects requiring strength of material and a material that cannot be easily oxidised. One of his earliest experiments was to take the somewhat spongy mass got by reduction of the oxide of nickel, and after heating it to full redness, work it under a steam hammer into a bar.

In 1873, Mr. Wharton sent to the Vienna Exhibition a sample of nickel in the form of axles and axle-bearings, and at the Exhibition in Philadelphia in 1876, he exhibited a remarkable series of objects made of *wrought nickel*, such as bars, rods, a cube, a horse-shoe magnet, and magnetic needles of forged nickel. These did not excite the interest to which they were entitled as a remarkable advance in the working of this little-known metal. The exhibit did not cause much comment, and it was not specially described or reported upon, so far as I am aware, except by the judges who reported the exhibit to the Commission as worthy of an award in the following terms: "A fine collection of nickel ores from Lancaster County, Pa., with nickel-matte, metallic nickel in grains and cubes, and manufactured nickel, both cast and wrought; nickel magnets and magnetic needles, cast cobalt, electro-plating with nickel and cobalt, and salts and oxides of both these metals; the whole showing a remarkable degree of progress in their metallurgical treatment."*

Some of the same objects formed of wrought nickel, were sent over to Paris two years later, and were exhibited in the American Section in 1878. There, as in Philadelphia, they did not at first excite any surprise, or receive any special attention. Very few persons realised what the objects really were, and that they were very different

* See Daubrée, *Substances Minérales*, p. 158.

† Cited in Gmelin, v., 361.

‡ *Comptes Rendus*.

* Reports and Awards, Group I., 640, p. 470.

from alloys of nickel. In fact, very few chemists had ever seen *nickel*. Pure nickel was a rarity, a curiosity, just as samples of indium or thallium are to-day.

You can then, perhaps, imagine the incredulity of the expert chemists and metallurgists of Europe, when whole ingots and forged bars of metal and numerous finished articles of pure wrought nickel, without alloy, were offered for their inspection. These articles not differing greatly in their appearance from the higher grades of nickel alloys, or from electro-nickelled objects, they passed them without surprise. No previous exhibition had been so rich in exhibits of the use of nickel and in the products from them. The influx of the pure carbonated and oxidised ores from New Caledonia, had greatly stimulated the nickel industry in Europe, and had improved the quality of the alloys of nickel. New companies had been formed to manufacture nickel silver and to produce nickel from these superior ores, at a lower cost than had before been possible. Christofle of Paris had just erected extensive works at St. Denis, and had made a most brilliant display of his products in one of the main avenues of the Exposition. The Vivians of Swansea and other exhibitors had large cases filled with beautiful objects of hollow and solid ware made of nickel silver. Amid these various exhibits of striking *tours de force*, the modest little show-case from the United States with examples of manufactures of *pure wrought nickel*, not alloy, could hardly be expected to excite attention and win the golden award, which was most cheerfully accorded as soon as the fact was demonstrated by analysis that the objects were really of the pure metal. Some of the objects now shown were of that exhibition, and have retained their brilliant polish and lustre unimpaired. These notable advances in the metallurgy of nickel, made with the lean and sulphuretted ores of Lancaster Gap, prepared the way for greater advances.

Dr. Fleitman, of Iserlohn, Westphalia, Prussia, has improved and cheapened the operation of refining the nickel and toughening it, and has reduced the liability to the presence of blow-holes in castings by adding to the molten charge, in the pot, when ready to pour, a very small quantity of magnesium. This is immediately decomposed, magnesia is formed, and graphite is separated. It would seem that the magnesium decomposes the occluded carbonic oxide, or reduces it to a minimum. The magnesium must be added with great care, and in small portions, as it unites explosively with the charge. It is stirred in. About one ounce of magnesium is sufficient for 60 pounds of nickel. Three-quarters of an ounce to 54 pounds of metal has been used with success by Mr. Wharton. The nickel from the ore at Lancaster Gap, seems not to require as much as the foreign metal. It is to be noted that complete malleability of nickel was obtained at Wharton's Works in Camden, before Fleitman's invention or process, but this last is more rapid and better than the old method. The metal so treated becomes remarkably tough and malleable, and may be rolled into sheets and drawn into wire. Cast plates can be successfully rolled. The cast plates, such as are made for anodes, after re-heating are rolled down to the desired thickness. It is found that it is a great improvement to the nickel anode plates to roll them down. They dissolve with greater uniformity in the bath. Nickel so treated with magnesium has been rolled into sheets as thin as paper. Expensive works for rolling the metal have been erected by Mr. Wharton at Camden. There is already a train of 40-inch rolls, 18 inches in diameter, with annealing ovens and gas furnaces and their adjuncts, and a 90 horse-power engine. At present this mill as well as the works for producing the metal, and the mine also, are "shut down."

The largest sheet yet rolled at Camden was 72 inches long and 24 wide, of pure nickel.

Dr. Fleitman has also succeeded in welding sheet nickel upon iron and upon steel plates, so as to coat them equally on each face with a layer of nickel. The quantity preferred by weight is 8-10ths iron and 3-10ths nickel,

1-10th of nickel being placed on each surface. To secure union the iron or steel must be perfectly flat and clean. A pile is made with outer facings of sheet iron to protect the nickel from scaling. When the whole is heated to the proper degree, it is passed through the rolls. The two metals become so firmly united that they may afterwards be rolled down, two or three together, or separately, to the thinness desired.

The samples exhibited were cut from sheets made at Mr. Wharton's works at Camden. One sample No. 20 gauge, 10 per cent nickel; one sample No. 22 gauge, 10 per cent nickel; one sample showing edge of sheet.

These are all examples of nickel upon iron. I also show a thin sheet of pure nickel annealed. The physical properties of the two metals, iron and nickel, are so nearly the same that they work well together. The nickel surface cannot be removed or regained in the scrap and waste except by dissolving out the iron core by dilute sulphuric acid. In the earlier experiments, the ingots or cast plates were beaten under the hammer; this produced a great deal of scale and waste, as with iron, but this is now avoided, partly by the device of a thin covering of sheet iron which is afterwards dissolved off. Dr. Fleitman claims to have produced steel wire similarly coated, and proposes to make nickelled boiler plates.

The applications in the arts of such nickelled iron sheets as I have described, will readily suggest themselves. Up to this time the most direct uses seem to be in making hollow ware, particularly culinary vessels. The manufacture has already begun at Schwerte, by Dr. Fleitman, and a great variety of vessels, such as saucepans and kettles have been turned out, some of them of pure sheet nickel. They are all very beautiful in appearance, resembling highly finished platinum vessels more than ordinary ware. When planished and buffed off, the surface becomes like a mirror, and will answer the purpose of one. The small vessel exhibited is made of nickelled iron, and will show the facility with which the compound sheet metal may be stamped, spun up, and polished. Much larger specimens of ware might be shown.

This ware is believed to be far superior to tinned iron or tinned copper for cooking in. The nickel is not only less liable to corrosion, but is harder, will wear longer, and cannot be melted off by overheating. The ware is lighter and stronger than tin or copper ware; is susceptible of a high polish and is not easily tarnished. It appears to be well adapted to the manufacture of dishes, salvers, and covers for the table. The coating of nickel applied by welding is stronger and tougher than that deposited by electrolysis, and appears to be less liable to scale off. The electrically deposited metal is in some cases very brittle, and no doubt contains sufficient hydrogen to essentially modify the physical characters of the coating.

My purpose in this article is chiefly to record some of the most notable advances in the metallurgy of nickel made in the United States, and particularly to direct attention to the production by Mr. Joseph Wharton at his works in Camden, before the year 1876, of *pure nickel* in a malleable state and in considerable quantities, and the manufacture of useful articles from it by forging and working it in the same manner as iron is forged and worked; thus exhibiting for the first time, in the "large way," the true physical characters of this metal, and its adaptation to many purposes in the arts, as had already been partly indicated, in the "small way," by scientific chemists in their laboratories.

I also desire to direct attention to the improved magnesium process of Dr. Fleitman; to the manufacture of nickelled iron and steel in rolled sheets, and to the industries which the possession of pure nickel in commercial quantities renders possible.

A New Preparation of Carbon Monoxide.—E. Noack.—Zinc powder heated in a Glaser furnace to 400° reduces carbonic acid to carbon monoxide.—*Ber. d. Deut.*

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY
SAMPLES OF WATER SUPPLIED TO LONDON DURING
THE YEAR 1882.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London
Hospital; Medical Officer of Health for Islington.

(Concluded from p. 78).

Wholesomeness.

IN the course of last autumn, the wholesomeness of the water furnished to London by the companies was publicly called in question by the insertion of two or three letters in the *Times*, attacking the character of the supply. The impeachment, though made as usual by writers unentitled to speak with authority, or to claim for themselves any special extent or means of information, seems nevertheless to call for some remark, as expressing the views entertained by a considerable number of persons who are unacquainted with the position in which the question at present stands. The general proposition as to the occurrence from time to time of serious cases of the outbreak and spread of zymotic disease, consequent on the distribution and consumption of impure water, and more especially of water contaminated with excremental matter, is admitted no less freely by those who maintain than by those who impeach the wholesomeness of the London water supply. Indeed, the very resort to chemical analysis as one means among others—and a very important means—of determining the wholesomeness of drinking water, presupposes the unwholesomeness of water more or less contaminated in some particular way; a presupposition which enforces on all concerned in furnishing, controlling, and advising on the supply of water to a community, the obligation of doing their utmost to ensure a wholesome supply and to guard it from every liability to noxious contamination. Starting from this common ground, a certain section of chemists and hygienists, undoubtedly including among their numbers persons alike of acknowledged eminence and capability and of special experience in sanitary questions, have formed an opinion highly unfavourable to the metropolitan supply; the use of which they regard as being at being at all times attended by more or less risk to the several million consumers of the water, and at certain times by a very considerable risk; as, for instance, in November last, when the water distributed by four out of the five companies taking their supply from the Thames was pronounced to be “unfit for drinking” by reason of its amount of “organic impurity.” On the other hand, another section of chemists and hygienists, including persons of not less eminence, experience, and independence, have come to the opposite opinion, that no grounds, capable of being sustained by fact and argument, exist for calling in question the wholesomeness of London water, or the freedom from risk attendant on its consumption. If the matter, however, rested here, the public might well have, despite the exceptional healthiness of London among great cities, some cause for uneasiness. But there is the further circumstance to be borne in mind that tribunal after tribunal has had the whole question under consideration,—has heard and inquired into the worst that could be alleged,—and with an unvarying result. The latest inquiry was that of the Royal Commission, who made their report in 1869, the pith of whose conclusion is comprised in the following paragraph from their report:—

“Having carefully considered all the information we have been able to collect, we see no evidence to lead us to believe that the water now supplied by the Companies is not generally good and wholesome.”

It does not of course follow that the conclusion even of

a Royal Commission, agreeing though it does with that of previous tribunals, is necessarily right; but it must at least be admitted to have a strong presumption in its favour. While also it does not follow necessarily that some other capable and impartial tribunal, with the same facts before it, would have arrived at the same conclusion, there is at any rate a strong presumption that it would. And anyhow, it would seem only fit and decorous that those who continue still to attack the quality of London water should make their attacks with some observance of respect for the results of judicial inquiry; and should abstain from imputing ignorance or bad faith to others whose well considered opinion, though different from their own, possesses the advantage of successive decisions in its favour.

But even after the many inquiries that have already been held, it is still open to objectors to make out, if they can, a *prima facie* case for yet further inquiry. The making out of such a case would seem to hinge upon the possibility of showing either that the condition of things as regards the source of supply, or the condition of knowledge as regards the natural history of zymotic disease, is so different now from what it was in 1869, that conclusions warrantable in 1869 are unwarrantable in the present day. Now, that the condition of things with regard to the source of supply has greatly improved since 1869, does not admit of question. Whether the present condition of knowledge with regard to the natural history of zymotic disease is so different from what the condition was in 1869 as to invalidate the conclusion then formed with regard to the wholesomeness of London water, it is for those who make the contention to show. A mere citation, however, of cases of disease-outbreak, more recent in date but similar in nature to those fully considered in 1869, would avail but little; while the usual appeal to prejudice, by sensational modes of statement and comparison, would serve no more worthy purpose than, in the language of reproof used by the Royal Commission, “to startle those unacquainted with the subject.”

We explained in our last annual report how it was “that a small proportion of organic matter, appreciably greater in winter than in summer, occurs as a normal constituent of most river waters; a constituent, however, which, as pointed out by the Commission on Water Supply, there is not any reason to regard as objectionable.” It is, of course, not without scientific interest to compare together river-water and spring-water in respect of a constituent which is thus characteristic of the one kind of water, and from which the other kind is relatively free. But it is quite another thing to stigmatise this normal river constituent as “organic impurity” or “organic pollution,” and to set up an arbitrary and perfectly individual scale of implied unwholesomeness, based upon the relative proportions of an unobjectionable constituent characteristic of the class of waters it is intended to disparage, and comparatively non-existent in the particular water it is intended to extol. Thus, in the report to the Registrar-General on the quality of the water supply of London during the month of September last, it was pointed out that the “amount of organic impurity” in the waters supplied by the Thames Water Companies was from $2\frac{1}{2}$ to $3\frac{1}{4}$ times that found in the water supplied from chalk wells by the Kent Water Company. But to avoid all risk of spoiling the moral, attention was not called to the circumstance that the mean “amount of organic impurity” in the Thames-derived waters was some 33 per cent below that recorded in the same table as existing in the much-vaunted, and deservedly vaunted, Loch Katrine water supplied to Glasgow. To have gone further even than this, and pointed out that, measured by the same standard, the “amount of organic impurity” in the Loch Katrine water was just double that found in the East London Company’s water and in the New River Company’s water, would have been, indeed, too suggestive of the obvious conclusion that perhaps the ingeniously contrived scale of unwholesomeness, by an appeal to which the water of the London companies is

month after month held up to public execration, is not of any high degree of trustworthiness after all. The circumstance that filtered Thames water, as supplied to London, contains a variable but always minute proportion of organic matter, amounting on the average to less than three-eighths of a grain, and never exceeding three-quarters of a grain per gallon, would be of significant importance only if it could be shown to be an unwholesome constituent of the water. But taking a series of years, and relying solely upon the water analysis supplied to the Registrar-General, it does, with singular perversity, happen that the years in which the metropolitan rate of mortality is exceptionally high are the years in which the "proportion of organic impurity" in the water is relatively low; while the years in which the metropolitan rate of mortality is exceptionally low are the years in which the "proportion of organic impurity" in the water is relatively high—not, of course, because the organic constituent of river water is any more wholesome than it is prejudicial, but most probably because the climatic conditions of the year which affected the rate of mortality in one way affected the proportion of organic matter in an opposite way. In illustration, however, of the occurrence of this inverse relationship, it is noticeable that in the successive years 1869, 1870, and 1871, in each of which there was the exceptionally high mortality of over 24 per thousand, the mean "proportion of organic impurity in Thames water," was represented by the number 912; while in 1872 and the successive years 1880 and 1881, in each of which there was the exceptionally low mortality of considerably less than 22 per thousand, the mean "proportion of organic impurity in Thames water" was represented by the number 1171; the proportion in the year 1868, with its mortality of 23½ per thousand, being represented by the number 1000.

Taking the amount of organic carbon as a measure of the organic matter present in the water, it is worth while to notice within what limits the actual proportions of organic carbon, and consequently of organic matter, are found to range. For the entire nine months preceding November last, the average amount of organic carbon in the water supplied by the Thames companies was, according to our experiments, 0.137 part in 100,000 parts of the water, the highest monthly mean being 0.181 part, and the maximum amount in any one sample out of the entire 154 samples examined, being 0.300 part. Throughout the month of November the river was in a quite exceptional state of flood; and with this flooded state, there was a marked increase in the proportion of organic carbon, so as to give a mean for the month of 0.294 part in 100,000 parts of water, with a maximum in one particular sample, out of the eighteen samples examined, of 0.381 part. Now although the ratio of organic carbon to the organic matter of river water is not positively known, and is doubtless variable within a certain range, it may be taken on a fair approximation to be about 40 per cent. Accordingly, on this assumption, the organic matter in one exceptional sample, out of the 203 samples of Thames water examined by us during the year, fell considerably short of three-quarters of a grain per gallon. The results, published in the report for November, made to the Registrar-General, were but a little higher than our own, yet from them was drawn the startling conclusion that the water supplied during the month by four of the Thames companies was so polluted as to be "unfit for drinking," a conclusion which we ventured to challenge in the following terms:—

"In our own previous monthly report we drew attention to the circumstance that, concurrently with the setting in of the winter season, there was, as there customarily is, a notable increase in the proportion of organic matter present in the water supply. In the report for the same period made to the Registrar-General, attention was also called to this increase; and further, the water distributed by four out of five of the Companies taking their supply from the Thames, was pronounced *ex cathedra* to be 'unfit for drinking' by reason of it

'organic impurity.' Now we take upon ourselves to assert that the analytical results set forth in the report, which are not appreciably different from our own, do not afford ground for any such appalling statement; and that the million or more consumers of the water furnished by these stigmatised companies, have not had their health in any way jeopardised by their consumption of the water supplied to them; and that they have not been placed, during the month of November, in any respect in a different position, as regards injury to health, consequent on the character of their drinking-water—admittedly unobjectionable in taste and appearance—from that in which they were placed during the summer months; when, owing to the different conditions of river life and change, the proportion of organic matter in the water, was about one-third or one-fourth of its recent amount—the maximum of which found in any sample, as recorded in the report to the Registrar-General, was under three-quarters of a grain per gallon, or amounted to about the one-thousandth part of one per cent of the reprobated water."

"As bearing on this question, we would recall to mind that the last Royal Commission on Water Supply, after hearing very varied scientific evidence, much of it of the usual alarmist character, reported to the effect that the presence of a small quantity of organic matter in drinking water was not necessarily prejudicial, and that there was not any evidence to satisfy them that the particular organic matter present in filtered Thames water was prejudicial."

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.
Chief Chemist to the U.S. Geological Survey, Washington.

NITROGEN.

(Concluded from p. 80.)

The ratio directly connecting silver nitrate with ammonium chloride has been determined only by Stas.† The usual method of working was followed; namely, nearly equivalent quantities of the two salts were weighed out, the solutions mixed, and the slight excess of one estimated by titration. In four experiments 100 parts of silver nitrate were found equivalent to chloride of ammonium as follows:—

31.489
31.490
31.487
31.486

Mean 31.488 ± 0.0006

The similar ratio between potassium chloride and silver nitrate has been determined by both Marignac and Stas.

Marignac‡ gives the following weights. I add the quantity of KCl proportional to 100 parts of AgNO₃:—

1.849	grm. KCl=	4.218	AgNO ₃	43.836
2.473	"	5.640	"	43.848
3.317	"	7.565	"	43.847
2.926	"	6.670	"	43.868
6.191	"	14.110	"	43.877
4.351	"	9.918	"	42.870

Mean 43.858 ± 0.0044

Stas'§ results are given in three series, representing silver nitrate from three different sources. In the third

* Smithsonian Miscellaneous Collections. "The Constants of Nature."

† "Aronstein's Translation," p. 209.

‡ "Berzelius's Lehrbuch," 5th edition, vol. iii., 1184, 1185.

§ "Aronstein's Translation," p. 308.

series the nitrate was weighed in vacuo, while for the other series this correction was applied in the usual way. For the KCl equivalent to 100 parts of AgNO_3 Stas found:—

First Series.

43·878
43·875
43·875
43·874

Mean 43·8755 \pm 0·0005

Second Series.

43·864
43·869
43·876

Mean 43·8697 \pm 0·0023

Third Series.

43·894
43·878
43·885

Mean 43·8857 \pm 0·0031

Combining all four series we have:—

Marignac..	..	..	..	..	43·858	\pm 0·0044
Stas, 1st series	..	..	..	..	43·8755	0·0005
„ 2nd	„	..	..	..	43·8697	0·0023
„ 3rd	„	..	..	..	43·8857	0·0031

General mean 43·8715 \pm 0·0004

There have also been determined by Penny and by Stas a series of ratios connecting the alkaline chlorides and chlorates with the corresponding nitrates. One of these, relating to the lithium salts, will be studied further on with reference to that metal.

The general method of working upon these ratios is due to Penny.* Applied to the ratio between the chloride and nitrate of potassium it is as follows:— A weighed quantity of the chloride is introduced into a flask which is placed upon its side and connected with a receiver. An excess of pure nitric acid is added, and the transformation is gradually brought about by the aid of heat. Then, upon evaporating to dryness over a sand-bath, the nitrate is brought into weighable form. The liquid in the receiver is also evaporated, and the trace of solid matter which had been mechanically carried over is recovered and also taken into account. In another series of experiments the nitrate was taken, and by pure hydrochloric acid converted into chloride; the process being the same. In the following columns of figures I have reduced both series to one standard; namely, so as to express the number of parts of nitrate corresponding to 100 of chloride:—

First Series.—KCl treated with HNO_3 .

135·639
135·637
135·640
135·635
135·630
135·640
135·630

Mean 135·636 \pm 0·0011

Second Series.— KNO_3 treated with HCl.

135·628
135·635
135·630
135·641
135·630
135·635
135·630

Mean 135·633 \pm 0·0011

* *Phil. Trans.*, 1839.

Stas'* results are as follows:—

135·643
135·638
135·647
135·649
135·640
135·645
135·655

Mean 135·6453 \pm 0·0014

These figures by Stas represent weighings in the air. Reduced to a vacuum standard this mean really becomes 135·6423.

Now, combining we have:—

Penny 1st series ..	..	..	135·636	\pm 0·0011
„ 2nd „ ..	..	..	135·633	0·0011
Stas ..	..	..	135·6423	0·0014

General mean .. 135·6363 \pm 0·0007

By the same general process Penny† determined how much potassium nitrate could be formed from 100 parts of chlorate. He found as follows:—

82·505
82·497
82·498
82·500

Mean 82·500 \pm 0·0012

For 100 parts of sodium chlorate he found of nitrate:—

79·875
79·882
79·890

Mean 79·8823 \pm 0·0029

For the ratio between the chloride and nitrate of sodium Penny made two sets of estimations as in the case of potassium salts. The subjoined figures give the amount of nitrate equivalent to 100 parts of chloride:

First Series.—NaCl treated with HNO_3 .

145·415
145·408
145·420
145·424
145·410
145·418
145·420

Mean 145·4164 \pm 0·0015

Second Series.— NaNO_3 treated with HCl.

145·419
145·391
145·412
145·415
145·412
145·412

Mean 145·410 \pm 0·0026

Stas gives the following series:—

145·453
145·468
145·465
145·469
145·443

Mean after reducing to vacuum standard 145·4526 \pm 0·0030

* "Aronstein's Translation," p. 270.
† *Phil. Trans.*, 1839.

Combining, we have as follows:—

Penny, 1st series.. ..	145'4164 ± 0'0015
„ 2nd „	145'410 0'0026
Stas	145'4526 0'0030

General mean 145'4185 ± 0'0012

We have now, apart from the determinations of gaseous density, nine ratios, representing 114 experiments from which to calculate the atomic weight of nitrogen. Let us first collect and number these ratios:—

(1.) Ag : AgNO ₃ :: 100 : 157'479 ± 0'0003
(2.) AgNO ₃ : AgCl :: 100 : 84'3743 0'0025
(3.) AgNO ₃ : KCl :: 100 : 43'8715 0'0004
(4.) AgNO ₃ : NH ₄ Cl :: 100 : 31'488 0'0006
(5.) Ag : NH ₄ Cl :: 100 : 49'597 0'0005
(6.) KCl : KNO ₃ :: 100 : 135'6363 0'0007
(7.) KClO ₃ : KNO ₃ :: 100 : 82'500 0'0012
(8.) NaCl : NaNO ₃ :: 100 : 145'4185 0'0012
(9.) NaClO ₃ : NaNO ₃ :: 100 : 79'8823 0'0029

From these ratios we are now able to deduce the molecular weight of ammonium chloride and of the three nitrates named in them. For these calculations we may use the already determined atomic weights of silver, oxygen, potassium, sodium, and chlorine, and the molecular weights of silver chloride and sodium chloride. These two molecular weights involve, respectively, the most probable values for silver sodium and chlorine. We cannot, however, appropriately use the directly determined molecular weight of potassium chloride, since the most probable value for the atomic weight of potassium is only in part derived from that salt. The following are the values which we shall employ:—

Ag	= 107'675 ± 0'0096
K	39'019 0'012
Na	22'998 0'011
Cl	35'370 0'014
O ₃	47'8899 0'0105
AgCl	143'045 0'0108
NaCl	58'3676 0'0052

Now from ratio number five we can get the molecular weight of ammonium chloride, NH₄Cl = 53'4048 ± 0'0048 and N = 14'0336 ± 0'0153.

From ratio number four an independent value for nitrogen can be calculated, viz., N = 14'0330 ± 0'015.

For the molecular weight of silver nitrate three values are deducible, namely:—

From (1)	AgNO ₃ = 169'5655 ± 0'0151
From (2)	„ 169'5362 0'0138
From (3)	„ 169'5612 0'0429

General mean „ 169'5489 0'0099

Hence N = 13'9840 ± 0'0174.

The molecular weight of potassium nitrate is twice calculable, as follows:—

From (6)	KNO ₃ = 100'8985 ± 0'0255
From (7)	„ 100'8801 0'0178

General mean „ 100'8863 0'0146

And N = 13'9774 ± 0'0216.

So also for sodium nitrate we have:—

From (8)	NaNO ₃ = 84'8773 ± 0'0076
From (9)	„ 84'8809 0'0099

General mean „ 84'8785 0'0060

And N = 13'9906 ± 0'0163.

We have now before us six estimates of the atomic weight of nitrogen. It only remains for us to combine these after the usual method as follows, in order to obtain the most probable value:—

1. From sp. gr. of N	N = 14'0244 ± 0'0039
2. „ ammonium chloride .. „	14'0336 0'0153
3. „ ratio number four .. „	14'0330 0'0150
4. „ silver nitrate	13'9840 0'0174
5. „ potassium nitrate .. „	13'9774 0'0216
6. „ sodium nitrate	13'9906 0'0163

General mean 14'0210 0'0035

If oxygen is 16, this becomes 14'0291. Stas found N = 14'044. The difference is 0'015, showing a remarkably close agreement.

NOTICES OF BOOKS.

MacIvor's Farmers' Annual. Edited by R. W. EMERSON
MACIVOR, F.I.C., F.C.S. Melbourne : Cameron,
Lang, and Co.

WE have here an agricultural year-book, specially adapted for the climate of Victoria. First comes a chemical-physiological discussion of the question : How plants grow. Next follows a calendar of farming operations with reference to such crops as arrowroot, tobacco, maize, &c., with which the farmer who has immigrated from England has but a scanty acquaintance. There are instructions on the recognition and treatment of red-rust, the greatest enemy of the Australian wheat-grower. Hop cultivation is described at great length, and recommended in a manner which will disgust the friends of "local option," at home and abroad. Wire-worms have to be provided against, though the species will probably be different from the *Agriotes* of England. Bush fires are judiciously ascribed not to spontaneous combustion, but to the careless use of matches. The remarks on manures are sound, but contain nothing calling for especial comment. Concerning the storage of water there is very valuable advice given, that requisite being not as in England, the farmer's great enemy, but frequently the one thing needed to convert a desert into a garden.

The School of Mines and Industries, Ballaarat, Victoria Australia. Ballaarat Science Lectures, First Series 1882: A Course of Popular Science Lectures, delivered in the Lecture Hall of the School during the Winter of 1882. Published under the Direction of the Council. Ballaarat : James McHutchison.

THIS work begins with an introduction on the use and value of popular science lectures. The writer quotes the memorable saying of Faraday : "Lectures which really teach will never be popular ; lectures which are popular will never really teach." He gives us also the more questionable dictum of Samuel Johnson : "You may teach chemistry by lectures, you may teach making shoes by lectures." We should not care to wear such shoes, and of lecture-taught chemistry we see and hear more than is edifying.

The first of the lectures, delivered by Mr. G. Foord, F.I.C., of the Melbourne Royal Mint, discusses alchemy, and gives a very popular, because humorous, history of mediæval chemistry, pharmacy, and medicine. Peter Wolfe, the well-known inventor of Wolfe's bottles, who died in 1805, is mentioned as the last of the alchemists. Of this we are by no means sure. There appeared in the *Athenæum*, between the years 1840-50, a strange advertisement offering to teach the "hermetic art" for a consideration. We have heard, too, that even at the present day one of the fraternity exists in London, but we have never met with him in person.

The second lecture of the Course, on the "Wonders of Coral Life," was delivered by the Rev. T. E. Ick. Prof. R. L. J. Ellery, F.R.S., the Astronomer Royal for Victoria, lectured on the "Sun's Distances and the Transits of

Venus." Mr. W. J. Thomas discoursed on the "Earth as a Planet." His lecture may do good service if the vagaries of "zetic astronomy" have penetrated to Australia. On a subsequent occasion the same lecturer took for his subject the "Stellar Universe." Dr. J. F. Usher discussed the "Human Body and Bones," concluding singularly enough with strictures on the "rank atheism, thinly veiled," of Prof. Tyndall's Belfast Address.

Baron F. von Müller, F.R.S., the Government Botanist, delivered a most interesting lecture on the "Flora of Australia." Prof. M. Smith took for his subject "Gold," and the concluding lecture of the Course, on the "Volcanic Rocks of the Ballarat District," was given by his colleague, Prof. F. M. Krause.

The School of Mines, Ballarat. Annual Report presented at the Meeting of Governors held Jan. 19, 1882. Published by Authority, School of Mines, Lydiard St., February 12, 1883.

THE Ballarat School of Mines is of somewhat complex character. In addition to mining, metallurgy, engineering, &c., it gives instructions in pharmaceutical chemistry. Its professorial staff is not numerous:—Mr. A. M. Smith, B.Sc., occupies the chairs of chemistry (inorganic, organic, technical, and pharmaceutical), of physics in all its branches, of botany, and of metallurgy; Mr. F. M. Krause teaches geology, mineralogy, scientific mining, surveying in all its branches, and is in addition curator of the museum. We hope that the remuneration of these gentlemen bears a fair proportion to the very heavy duties devolving upon them. In the annual report the value of the operations of the School and the necessity for increased support from the public are very ably enforced.

We learn that the metallurgical laboratory is now fitted with twelve melting furnaces, three cupellation furnaces, and one blast-furnace. The students are supplied with fuel, pots, fluxes, and all other requisites free of any charge beyond the ordinary Term Fee. A Field Club has also been established for the purpose of outdoor study in geology, mineralogy, &c. It was proposed to found classes in agricultural chemistry, but, we regret to learn, without any practical results. A course of four public lectures has been delivered by Prof. Smith on bleaching and dyeing, and on the manufacture of soda and sulphuric acid. During the winter of 1882, a course of popular lectures have been delivered on various scientific subjects. Several important additions have been made to the museum, but the curator complains that the objects in every department are now far too crowded for convenient and instructive exhibition, and additional space and light have become matter of absolute necessity. We can only hope that the requisite funds will be forthcoming.

CORRESPONDENCE.

YELLOW HYDROCHLORIC ACID.

To the Editor of the Chemical News.

SIR,—In "A Treatise on Chemistry," by H. E. Roscoe, F.R.S., and C. Schorlemmer, F.R.S. (New Edition, 1881), at page 136 it is stated that the aqueous hydrochloric acid obtained in the manufacture of soda-ash is "usually of a yellow colour, due to organic matter," and, in the list of its impurities, iron is not mentioned. In "Miller's Elements of Chemistry" (1868), at page 124, it is said that "Commercial hydrochloric acid is liable to be contaminated with iron, which gives it a yellow colour."

As I fancied that I had acquired, in my humble way, some knowledge of this important chemical, I experienced a shock of mental earthquake on reading the former statement. For consolation, I immediately had

recourse to the bottle—of yellow hydrochloric acid—with which I made the following experiments:—

(1.) A small fragment of zinc bleached it at once, and chlorine-water restored the yellow colour.

(2.) After dilution with water it gave a dark blue with potassium ferrocyanide.

(3.) Potassium ferridcyanide gave no blue colour until the acid had been decolourised by zinc.

(4.) Potassium sulphocyanide gave a strong pink colour with the diluted acid.

(5.) Ammonia in excess and ammonium sulphide gave a dark green precipitate, which dissolved in HCl, and gave a dark blue with potassium ferridcyanide.

On adding a little ferric chloride to colourless hydrochloric acid the same yellow shade was obtained, and the liquid gave the same reactions as the commercial yellow acid.

My own equanimity being thus restored, I hope you will kindly allow me to preserve others from the shock experienced by—

A PRACTICAL CHEMIST.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvi., No. 6, August 6, 1883.

Reclamation of Priority with Reference to a Communication by M. Jamin on the Critical Point of Liquefied Gases.—W. Ramsay.—The author shows that the principal points in M. Jamin's memoir on the critical point of liquefied gases had been anticipated in his (Mr. Ramsay's) communication found in the *Proceedings of the Royal Society*, April 22 and December 16, 1880.

Application of Ampère's Method to the Discovery of the Elementary Law of Electric Induction by Variation of Intensity.—M. Quet.

Measurement of Differences of Potential by means of the Galvanometer.—L. Thévenin.—These two mathematical papers do not admit of useful abstraction.

Boron.—A. Joly.—The author summarises the results of Sainte-Claire Deville and of Hampe, points out their discrepancies, and shows that the respective analyses of Sainte-Claire Deville and Wöhler, and of Hampe, have been made upon different products. He distinguishes among the products formed on the reduction of boric acid by aluminium: A boride, BoAl , in hexagonal lamellæ of a golden yellow, which has been studied by Deville and Wöhler; a boride, Bo_2Al , in large black lamellary crystals; quadratic yellow crystals of a fine adamantine lustre, containing carbon and aluminium; a boron carbide, or probably several carbides, derived from the transformation of the preceding compounds at an elevated temperature, in presence of carbon and boric acid in excess.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin. Vol. 16, No. 1.

History of the Meta-nitriles.—O. Wallach.—A polemical paper directed against H. W. Städel.

The Primary and Secondary Naphthylamines.—G. Benz.—The author treats of the action of ammoniacal calcium chloride upon β -naphthol and α -naphthol; the behaviour of the same two bodies with ammoniacal zinc chloride; the production of α - and β -dinaphthylamines by the action of dehydrating agents upon mono-naphthols and mono-naphthylamines; and the picrates and acetyl derivatives of the secondary naphthylamines.

Derivatives of Brom-acetophenon and Aceto-phenon.—W. Städel.—Not adapted for abstraction.

Phenacyl-ethyl-anilide.—A. Weller.—The author has studied the base obtained by the reaction of brom-acetophenon upon diethyl-aniline. He describes it as insoluble in water, sparingly soluble in alcohol, more readily in ether, benzol, and carbon disulphide. It melts at from 94° to 95°. It dissolves easily and readily in hydrochloric acid, and is partially precipitated on the addition of water.

Hydrobromates and Hydriodates of Aromatic Bases.—W. Städel.—A description of the ortho-toluidine hydrobromate, toluidine hydriodate, and the corresponding para-compounds. Xylidine hydrobromate, meta-chlor-aniline hydrobromate, the corresponding para-compound, meta-nitro-aniline hydrobromate, and meta-phenetidine hydrobromate. All these compounds, except the salts of para-toluidine and meta-nitro-aniline, crystallise very readily; their solutions have an acid reaction, and they take up large quantities of the free bases without losing the acid reaction.

Methylation and Ethylation of Aniline and Toluidine.—H. Reinhardt and W. Städel.—An account of mono-methyl-aniline, dimethyl-aniline, mono-ethyl-aniline, diethyl-aniline, mono-methyl-ortho-toluidine, dimethyl-ortho-toluidine, and the corresponding para-compounds.

Nitro-ethyl-aniline.—A. Weller.—A preliminary communication. The author obtains this compound by treating ethyl-acetanilide with an excess of cold nitric acid, sp. gr. 1.52, under refrigeration.

Dimethyl-xylidines, Dimethyl-meta-chlor-aniline, and Dimethyl-meta-phenetidine.—H. vom Baur and W. Städel.—A preliminary communication, in which the two last mentioned bodies are briefly described.

Ortho-nitro-cinnamyl-acet-acetic Ether.—E. Fischer and H. Kuzel.—The authors have studied the formation of ortho-nitro-cinnamyl-acetone and ortho-nitro-cinnamyl-methyl-ketone.

Formation-heat of the Chlorine Compounds of Phosphorus and Arsenic.—Julius Thomsen.

Formation-heat of the Chlorides and Oxides of Antimony and Bismuth.—Julius Thomsen.—These two papers give important thermo-chemical data in a tabular form.

Synthesis of α -Naphthol.—R. Fittig and H. Erdmann.—The authors obtain this compound by distilling lactic acid.

The Occurrence of Coniferine in the Lignified Tissues of the Sugar Beet.—E. O. von Lippmann.—The nature of this paper appears sufficiently from the title.

The Action of Iodine upon Mono- and Di-nitro-diphenyl-thio-carbamide.—S. M. Losanitsch.—By this reaction the author obtained a mixture from which he has separated nitraniline, phenyl-myrosine, meta-nitro-phenyl-mono-thio-urethan, and meta-nitro-triphenyl-guanidine. The two latter of these compounds are here described.

The Oxidation of the Nitro-toluoles with Potassium Ferricyanide.—W. A. Noyes.—Ortho- and nitro-toluoles are oxidised in this manner, just as by alkaline permanganate.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Corrosion of Boilers.—In the *Times* of August 20th occurs a paragraph reporting the meeting of the French Association for the Advancement of Science at Rouen. Therein a paper is mentioned on the "Corrosion of Boiler Plates and the Use of Zinc Plates to Prevent the same." Could any of your readers oblige with references to the right source for a full report of this paper?—OLD SUBSCRIBERS.

OWENS COLLEGE, VICTORIA UNIVERSITY, MANCHESTER.

SESSION 1883-84.

I. DEPARTMENT OF ARTS AND LAW.

II. DEPARTMENT OF SCIENCE AND ENGINEERING.

Candidates for admission in these Departments must not be under 14 years of age, and those under 16 will be required to pass an Entrance Examination in English, Arithmetic, and Elementary Latin, to be held on the 28th September.

III. DEPARTMENT OF MEDICINE AND SURGERY.

Students are required before entering to have passed one of the Preliminary Examinations prescribed by the General Medical Council.

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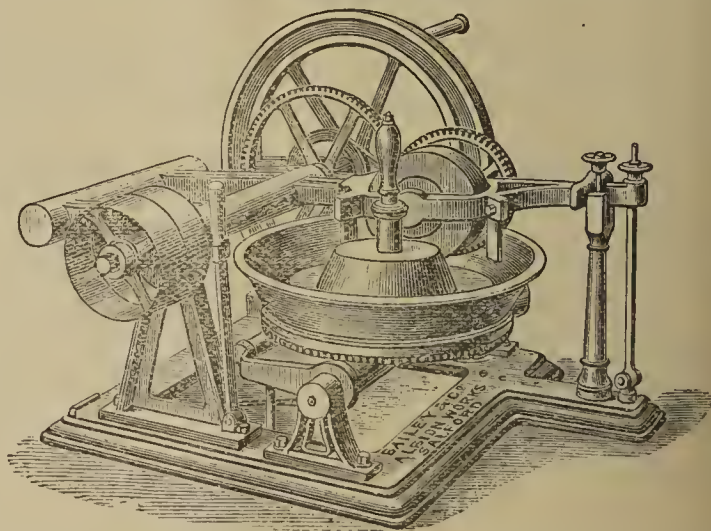
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THE CHEMICAL NEWS.

VOL. XLVIII. No. 1240.

NOTES OF WORK BY STUDENTS OF PRACTICAL CHEMISTRY IN THE LABORATORY OF THE UNIVERSITY OF VIRGINIA.

No. XII.

Communicated by J. W. MALLET,
Professor of General and Applied Chemistry in the University.

(95.) *On Antimony Pentiodide.* By J. H. PENDLETON, of
Louisa Courthouse, Virginia.

Two or three years ago Mr. F. Hampton, then a student in this laboratory, obtained evidence of the existence of an instable pentiodide of phosphorus,* and more recently Mr. B. E. Sloan, also working here, reached the same result in regard to pentiodide of arsenic.† Mr. Pendleton has examined into the possibility of forming a parallel compound of iodine with antimony.

Carefully purified metallic antimony was fused with an excess of pure iodine, in an atmosphere of an inert gas, in a sealed tube kept at a temperature above the fusing-point of the mixture for an hour or two. The end of the tube containing the material was then heated, in a bath of sulphuric acid, to various temperatures and for various lengths of time in successive experiments, while the other end was kept cold by ice-water, and served to collect the surplus iodine distilled off. The tube having been cooled down and opened, the residual material was submitted to analysis, the iodine being determined with the aid of sodium thiosulphate, and the antimony as tetroxide after careful treatment with nitric acid.

When the heating-bath had been kept at a temperature not exceeding 130°C ., the residue gave results corresponding pretty closely to the formula SbI_5 , and consisted of a homogeneous mass, of crystalline structure, and dark brown colour, distinctly different in appearance from the red tri-iodide, decomposable by water or on prolonged exposure to moist air. The fusing-point was between 78° and 79°C ., notably lower than that of either the tri-iodide, or free iodine, and agreeing in this relation with what had been observed by Mr. Sloan for the corresponding compound of arsenic. Antimony pent-iodide is, however, a very unstable substance, readily undergoing partial dissociation by exposure to moderate increase of temperature. In this respect, also, it forms a parallel to the pent-iodides of arsenic and phosphorus.

(96.) *On the Condensation to Liquid Form of Nitrogen Trioxide.* By R. H. GAINES, of Mossingford, Virginia.

It has often been stated, in reference to the surface condensation of gases by porous solids, that in some cases at least the gas is very probably brought to the liquid state in the pores in which it accumulates. Some of these statements were apparently made before Andrew's "critical-point" of temperature had been studied, and have been repeated without due consideration of its bearing upon the impossibility of liquefying certain gases at common temperatures by any mere diminution of volume. It seems possible, however, that the liquefaction of a gas, the "critical-point" of which was not too low, by absorption into the pores of an inert solid, might be rendered visible if the colour of the substance were not the same in

the gaseous and liquid states. Such a case for experiment appeared to be presented by nitrogen trioxide, orange in the former, but blue in the latter state, assuming that the identity of the substance is preserved in passing from the one to the other.

Mr. Gaines prepared crude nitrogen trioxide by heating nitric acid with arsenious oxide, drying the orange mixture of gases by passage over calcium chloride, and condensing by a freezing mixture. From the dark green liquid so obtained purer N_2O_3 was produced by gently warming the liquid, passing through it a current of nitrogen dioxide (from nitric acid and ferrous sulphate), conducting the gaseous mixture through a coil of heated glass tube, and thoroughly drying the product by two long calcium chloride tubes and a tube of phosphorus pentoxide. A still better, apparently quite pure, product was obtained by condensing by a freezing mixture the material derived from this last process, and using it as the starting-point for a repetition of the same method, employing carefully purified and dried nitrogen dioxide. Finally, the pure N_2O_3 in gaseous form was carried in succession through three condensing tubes immersed in the same cooling bath and maintained at the same temperature. The first and last of these were empty; the intermediate one contained light gray spongy platinum.* Gradually lowering the temperature of the bath containing these tubes, it was repeatedly found that condensation to a dark coloured liquid occurred simultaneously in all three, no difference being observed in the case of the spongy platinum when care had been taken to dry it thoroughly beforehand. In a first experiment, in which this precaution was omitted, a blue colour developed on the platinum before condensation had occurred in the empty tubes.

While the main result looked for was thus simply a negative one, two points observed in connection with it are worth recording.

In the first place, nitrogen trioxide has been generally described as a blue liquid. Hasenbach† states that at ordinary temperatures it is dark blue, changing at -10°C . to a splendid indigo-blue. The liquid obtained by Mr. Gaines in its purest state had a dark green colour, but this changed to blue on addition of a very little water. When only a very small portion had become blue this (nitrous acid?) did not readily mix with the remainder, which was still green.

In the second place, although there do not seem to be exact observations on record as to the temperature at which liquefaction of nitrogen trioxide occurs under ordinary pressure, the directions of the text-books with respect to the freezing mixtures to be used seem to imply that quite a low temperature is necessary. Mr. Gaines, in several experiments, and using different specimens of the trioxide, observed uniformly $+14.4^{\circ}\text{C}$. as the temperature of condensation under a pressure of 755 m.m. When the liquid so obtained was heated, ebullition began—whether splitting-up be supposed to occur or not—at just the same temperature.

(97.) *Unsuccessful Attempts to Prepare a Carbonyl Iodide analogous to Phosgene.* By S. P. COWARDINS, of Richmond, Virginia.

A number of experiments were tried with a view to preparing the compound COI_2 . The chief of these may be briefly mentioned, though none led to the desired result.

Dry carbon monoxide and iodine in the proper proportions were introduced into a large flask, which was hermetically sealed, and exposed day after day to the light—much of the time to the direct rays of the sun when quite bright. After two months there was no apparent change.

Carbon monoxide was dried and passed through a bulb containing iodine. The bulb was heated, and the mixture of gas and vapour was passed on to condensing tubes

* CHEMICAL NEWS, vol. xlii., p. 180.

† *Ibid.*, vol. xlii., p. 194.

* Asbestos and other porous materials were also tried, but with no difference of result.

† *Four. f. Prak. Chem.* [2], iv., 1.

surrounded by ice and salt. Iodine condensed unchanged in the tubes, and carbon monoxide escaped unchanged.

The last experiment was repeated, interposing a coil of strongly heated glass tube between the iodine bulb and the condensing tubes: the result was as before.

Carbon monoxide was passed through heated arsenic pentiodide, and thence on to the condensing apparatus. The pentiodide of arsenic was partly reduced to tri-iodide (as it would have been by dissociation if heated alone), iodine condensed in the tubes, and carbon monoxide escaped.

Carbon monoxide was heated, and passed over red-hot iodide of lead, with no detectable effect.

Carbonyl chloride was prepared—in one case by the action of carbon monoxide on antimony penta-chloride, in another by passing carbon monoxide and chlorine through heated animal charcoal—and was then carried over potassium iodide, and so on to the condensing tubes. The potassium iodide was partially decomposed, but iodine alone was condensed, and carbon monoxide escaped. A little chloride of iodine was also observed to be formed.

Several of these experiments were repeated with modifications in detail, but with no result worthy of record.

(98.) *Analysis of Gibbsite, from Marianna, Province of Minas Geraes, Brazil.* By W. C. EUSTIS, of Washington, D.C.

The specimen examined—from a locality in Brazil not heretofore mentioned, as far as I have seen—was given me by Prof. Orville A. Derby, Director of the Section of Mineralogy and Geology in the National Museum, Rio de Janeiro. It seemed to represent a small seam or vein in talcose slate, for the most part nearly pure, but associated on the outside with a little crust of oxide of iron.

The mineral was greyish white to nearly colourless, with sub-vitreous lustre, tending towards silky in some places. The surface was mammillary, and the structure radiate or fibrous. Hardness=3. Specific gravity=2.4. Whitened before the blowpipe flame, losing water, but did not fuse. Analysis gave—

Al ₂ O ₃	..	..	..	..	..	63.81
H ₂ O	..	..	..	..	..	35.85
Fe ₂ O ₃	..	..	..	..	..	0.49
CaO	..	..	..	..	..	0.30
MgO	..	..	..	..	..	0.03
SiO ₂	..	..	..	..	..	0.20

100.68

These figures agree well with the formula of the trihydrate, Al(HO)₃.

Aluminium phosphate was carefully tested for, but none was present. The dark coloured incrustation on the outside contained, beside iron, a little manganese and traces of cobalt and nickel.

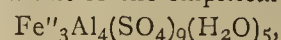
(99.) *Analysis of a Native Ferrous and Aluminic Sulphate, from Tepeji, State of Mexico, Mexico.* By T. P. LIPPITT, of Charlestown, West Virginia.

This mineral was sent me by Prof. Mariano Bárcena, of the City of Mexico. Its physical characters had been described by him, but its chemical composition had not been examined.

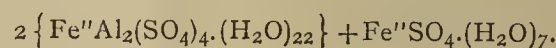
The specimen consisted of a compact mass of delicate silky fibres, parallel and adherent, but easily detachable from each other, like those of asbestos. The fibres were flexible to a considerable extent. Colour pale greenish white. Lustre silky and shining. Hardness=2. Specific gravity=1.89 (taken in benzene). Soluble in water. Gave off acid water on being heated in a glass tube. A little gypsum occurred intermixed with the pure mineral, which otherwise seemed under the microscope to be perfectly homogeneous. This foreign substance was removed as far as possible, and the purified material gave on analysis—

Fe"	..	..	..	..	..	7.81
Al	..	..	..	..	..	4.92
Ca	..	..	..	..	..	0.52
SO ₄	..	..	..	..	..	41.59
H ₂ O	..	..	..	..	..	43.60
						98.44

The iron proved to exist altogether in the ferrous condition. Subtracting the constituents of gypsum corresponding to the small amount of calcium found, these figures represent a salt of the empirical formula—



equivalent to two molecules of halotrichite plus one of melantrite:—



(To be continued.)

ON CERTAIN SUBSTANCES OBTAINED FROM TURMERIC.—CURCUMIN.

By C. LORING JACKSON and A. E. MENKE.

THE following paper* contains a description of our experiments on the action of nascent hydrogen and of bromine upon curcumin.

Action of Nascent Hydrogen.

Dihydride of Curcumin, C₁₄H₁₆O₄.—This substance was made by the action of sodium amalgam and water upon curcumin. The best result was obtained when a mixture of curcumin, dilute alcohol, and strong sodium amalgam was allowed to stand for somewhat more than a week. The alcohol, though not absolutely necessary, as the sodic hydrate formed gradually brings the curcumin into solution, accelerates the action, which at best is extremely slow. After the dark red colour of the sodic salt of curcumin had given place to a blackish tinge, the liquid was poured off from the mercury, acidified with hydrochloric acid, the fawn-coloured precipitate thus obtained washed till free from acid, and dried *in vacuo*. A combustion gave the following results:—

0.2290 grm. of substance gave 0.5678 grm. of CO₂ and 0.1312 grm. of H₂O.

	Calculated for C ₁₄ H ₁₆ O ₄	Found.
Carbon	.. .. 67.74	67.63
Hydrogen	.. .. 6.49	6.36

Properties.—It forms a brownish-white powder, melting in the neighbourhood of 100°, but with no definite melting-point; it is insoluble in water, freely soluble in alcohol and glacial acetic acid, slightly in ether, and insoluble in ligroine and benzol. Strong sulphuric acid dissolves it with a reddish-brown colour, very different from the purple produced by curcumin. Sodic hydrate dissolves it on warming, and so does sodic carbonate; but the latter solution becomes turbid, and throws down a brownish precipitate on cooling.

The addition of hydrogen to curcumin by sodium amalgam and dilute alcohol is a tedious process, occupying more than a week and giving a very bad yield, the product being frequently accompanied by a viscous substance, probably formed by the action of air on the alkaline solution of the hydride. A much better method of adding hydrogen to curcumin consisted in treating it with zinc dust and acetic acid, although in this case the hydride at first produced was further modified in the course of the reaction.

Anhydride of Curcumin Dihydride (C₁₄H₁₅O₄)₂O.—Curcumin was warmed with acetic acid of 85 per cent and a large quantity of zinc dust, the temperature being kept

* See previous article, CHEMICAL NEWS, vol. xlvii, p. 61.

below the boiling-point of the acetic acid. After some hours the yellow colour of the solution had become replaced by a dark brown, and if then a little of the substance gave a yellow instead of a red colour with sodic hydrate, the heating was discontinued, and the liquid filtered into water, which precipitated fawn-coloured flocks similar to those of the preceding compound. After we had satisfied ourselves that it was impossible to crystallise the substance, we purified it by re-solution in glacial acetic acid and precipitation with water; but even this treatment did not remove the whole of the zinc salt, as was shown by the appearance of a slight ash on combustion. This has been subtracted from the weight of the substance taken in calculating the percentages.

The same substance was obtained when curcumin was heated with zinc dust and a solution of ammoniac hydrate. The combustion marked III. was of a product made in this way:—

The substance after thorough washing with water was in each case dried on a steam radiator at a temperature of about 60°.

I. 0.2552 grm. of substance gave 0.6460 grm. of CO₂. 0.1476 grm. of H₂O. Ash=0.004.

II. 0.2449 grm. of substance gave 0.6183 grm. of CO₂. 0.1368 grm. H₂O. Ash=0.0061.

III. 0.2357 grm. of substance gave 0.6001 grm. of CO₂. 0.1365 grm. of H₂O. Ash=9.002.

	Calculated for C ₂₈ H ₃₀ O ₇ .	Found.		
		I.	II.	III.
Carbon	70.42	70.14*	70.61*	70.03*
Hydrogen	6.25	6.53	6.36	6.48

Properties.—It resembles the dihydride closely, like it forming a dirty white powder, with no definite melting-point, since it melts gradually in the neighbourhood of 120°. The best solvents for it are alcohol and glacial acetic acid, but it is deposited on evaporation of the solvent as a varnish. It is essentially insoluble in ether, ligroine, and benzol, slightly soluble in chloroform. A solution of potassic hydrate dissolves it with a yellow colour, while potassic carbonate forms a dark brown solution if boiled with it, but as this solution cools, brownish flocks are deposited, which we supposed to be a potassium salt, until two analyses of the substance showed that it did not contain more than 2.5 per cent of potassium, whereas the salt with the least possible amount of the metal contains 7.5 per cent. It is evident, therefore, that the potassium was an impurity, which could well be, since we were able to find no satisfactory method of purification. An attempt to make a potassium salt with alcoholic potassic hydrate gave a black liquid, insoluble in a mixture of alcohol and ether, and of the most unpromising appearance.

The fact that the substance forms no salt with potassic carbonate indicates that the two molecules of the dihydride are connected by the removal of water from their carboxyl groups; but we did not consider the nature of the substance satisfactorily explained until we succeeded in making it from the dihydride, C₁₄H₁₆O₄, by the action of an acetic acid solution of zincic acetate. After warming the two substances together for some time, the product was treated with water, and the precipitate washed, dried, and analysed, with the following result:

0.1430 grm. of substance gave 0.3666 grm. of CO₂ and 0.0868 grm. H₂O.

	Calculated for C ₂₈ H ₃₀ O ₇ .	Found.
Carbon	70.42	69.92
Hydrogen	6.25	6.68

Whereas before this treatment a portion of the same sample gave carbon 67.63, hydrogen 6.36, as above. This

* If the ash is not subtracted the percentages are—

I.	II.	III.
69.04	68.85	60.44
6.43	6.20	6.43

experiment proves, therefore, that the nascent hydrogen given off by zinc dust and acetic acid first converts the curcumin into the dihydride, from which the zincic acetate afterwards removes one molecule of water. The anhydride is broken up only incompletely by the action of water at high temperatures or by boiling with sodic hydrate, the product in each case being a mixture of the dihydride and anhydride.

In order to study the oxidation of the dihydride, some diethyl-curcumin, prepared according to the method given in our first paper, was treated with zinc dust and acetic acid. The product thus obtained gave the following results on analysis, which indicate that it is a mixture of di- and mono-ethyl-curcumin dihydride:—

I. 0.2130 grm. of substance gave 0.5484 grm. of CO₂ and 0.1415 grm. of H₂O. Ash 0.0004.

II. 0.1938 grm. of substance gave 0.4986 grm. of CO₂ and 0.1336 grm. of H₂O.

	Calculated for (C ₂ H ₅) ₂ C ₁₄ H ₁₅ O ₄ .	I.	Found.	II.	Calculated for (C ₂ H ₅) ₂ C ₁₄ H ₁₅ O ₄ .
Carbon	69.59	70.35	70.15		71.05
Hydrogen	7.25	7.40	7.66		7.89

Some of this substance was mixed with a saturated neutral solution of potassic permanganate and allowed to stand at the ordinary temperature. The oxidation took place very slowly, several weeks' standing being necessary to complete the reaction. The principal product, was proved by its melting-point to be ethyl-vanillic acid, while the presence of a small quantity of ethyl-vanillin was indicated by its characteristic smell.

The most striking fact in connection with this reaction was that the dihydride was oxidised with much more difficulty than curcumin itself.

Action of Bromine on the Anhydride of Curcumin Dihydride.—When the hydride, dissolved in glacial acetic acid, was mixed with an excess of bromine and allowed to stand over night, the liquid turned black, and upon addition of water, a red precipitate was thrown down, which was washed with water, dried, and analysed:

I. 0.6652 grm. of substance gave 0.7160 grm. of CO₂ and 0.1122 grm. of H₂O. 0.3100 grm. gave according to Carius 0.4125 grm. of AgBr.

II. 0.3202 grm. gave 0.3498 grm. of CO₂ and 0.0562 grm. of H₂O. 0.2786 grm. gave 0.3730 grm. of AgBr.

	Calculated for C ₁₄ H ₁₀ Br ₄ O ₄ .	I.	Found.	II.
Carbon	29.89	29.36		29.80
Hydrogen	1.78	1.87		1.95
Bromine	56.94	56.62		56.99

The substance is red and amorphous; it does not melt under a red-heat, but seems to be decomposed without melting. It is insoluble in water, ligroine, and benzol, very slightly soluble in alcohol and ether, soluble in glacial acetic acid. Strong sulphuric acid has no action upon it. It is vigorously acted on by boiling potassic hydrate, forming a red solution from which acids precipitate a black tarry body which we were unable to purify; two analyses of its sodium salt, however, showed that it contained about the same percentage of oxygen as of carbon, and that most of the bromine (all but 7 per cent) had been removed, proving that the bromine in the original substance is all in the side chain.

Action of Bromine on Curcumin.

We have obtained two bromine compounds of curcumin, one containing four and the other seven atoms of bromine.

Tetrabromide of Curcumin, C₁₄H₁₄Br₄O₄.—When curcumin suspended in carbonic disulphide is allowed to stand with an excess of bromine for some hours, it is converted into a white substance, which is left as the carbonic disulphide evaporates. The carbonic disulphide can be replaced by glacial acetic acid, but in this case an excess of bromine or the use of a large quantity of glacial acetic acid must be avoided. The nature of this body

could not be established satisfactorily by analysis, as it was more or less decomposed by all its solvents, and therefore a thorough purification was impossible; we have obtained one fair analysis, however, of a sample washed with carbonic disulphide.

0.2375 grm. of substance gave according to Carius 0.3180 grm. of AgBr.

	Calculated for $C_{14}H_{14}Br_4O_4$.	Found.
Bromine	56.66	56.99

Other specimens contained the following percentages:—

Bromine	54.87	58.51	58.57
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To confirm this result, which points to the taking up of four atoms of bromine, we determined the increase of weight caused by the bromine. For this purpose carbonic disulphide and bromine in excess were added to a weighed amount of curcumin, and the product weighed after drying it a little below 100°.

I. 0.252 grm. of curcumin gained 0.354 grm.

II. 0.218 grm. gained 0.300 grm.

These results correspond to the following percentage of bromine in the product:—

	Calculated for $C_{14}H_{14}Br_4O_4$.	I.	Found.	II.
Bromine	56.66	58.41		57.91

And there is therefore no doubt that the substance contains four atoms of bromine. To decide whether it was an addition or substitution product, we determined the amount of hydrobromic acid given off, as in every preparation an evolution of this gas was observed. For this purpose the gases formed in the reaction were allowed to pass through water, and finally the carbonic disulphide and excess of bromine were removed, at first from the curcumin, and afterward from the absorbing water, by a stream of air; the hydrobromic acid collected in the water was then determined as argentic bromide. One grm. of curcumin was used in each case, and in the following comparison of results the amounts found are compared with the calculated amount if the curcumin had given off two molecules of hydrobromic acid:—

Two Molecules HBr.	I.	II.
0.66	0.185	0.28

From this it appears that the hydrobromic acid is produced by an insignificant secondary reaction, and that the substance is an addition product, and therefore has the formula $C_{14}H_{14}Br_4O_4$.* We may add that some experiments to determine directly the number of molecules of bromine added pointed to two molecules as the probable amount, but the results are not definite enough to make them worth publishing.

Properties.—It is a white or whitish amorphous substance, melting in the neighbourhood of 185° with decomposition, but it has no definite melting-point. It is insoluble in water, soluble with decomposition in alcohol and in glacial acetic acid, which acts upon it, however, less rapidly than the alcohol, very slightly soluble in ether, chloroform, and carbonic disulphide, insoluble in ligroine and benzol. Its behaviour with various reagents was taken up, but no results were obtained which promised to repay further study. The following observations, however, are of some interest. Potassic hydrate and also argentic oxide convert it in part into vanillin, to judge from the smell, while both anilin and zinc cleaned with sulphuric acid act upon it, the former with considerable evolution of heat,—thus confirming the inference that it is an addition product. The principal products from these reactions, as well as those from the action of sodic carbonate and water, and of reducing agents, are ill-defined bodies which we could find no means of purifying.

* The high percentages of bromine obtained in the analyses may be accounted for by this secondary reaction.

Pentabrom-curcumin-dibromide, $C_{14}H_9Br_7O_4$.—If curcumin in glacial acetic acid is treated with an excess of bromine, or the solid tetrabromide treated with bromine, a red substance is formed, which, after washing with water and drying *in vacuo*, gave the following results:—

0.2898 grm. of substance gave 0.2230 grm. of CO_2 and 0.0304 grm. of H_2O .

0.2666 grm. of substance gave according to Carius 0.9323 grm. of AgBr.

	Calculated for $C_{14}H_9Br_7O_4$.	Found.
Carbon	20.97	20.98
Hydrogen	1.12	1.16
Bromine	69.91	69.02

Properties.—A red amorphous substance melting near 120°, but without definite melting-point; insoluble in water, soluble in alcohol apparently with decomposition, easily soluble in ether and glacial acetic acid, leaving a varnish, slightly soluble in benzol, insoluble in ligroine. Strong sulphuric acid acts on it very slowly, finally turning it a more brilliant red. Our study of the behaviour of this substance has led to no more definite results than in the case of the tetrabromide.

Heated alone, it gives off bromine and hydrobromic acid, leaving a black tar, from which a yellow substance containing bromine can be extracted by alcohol; we may study this experiment more carefully hereafter. Sodic hydrate, sodic carbonate and water, sodic alcoholate, and argentic oxide all act upon it, but no smell of vanillin was observed in any case. The same is true of several oxidation experiments we have tried upon it, and this would seem to indicate the presence of a portion of the bromine in the benzol ring. It is an interesting fact that potassic dichromate and sulphuric acid, and also neutral potassic permanganate, attack this substance only with extreme difficulty, whereas they both act vigorously on curcumin.

SUMMARY.

1. Curcumin takes up two atoms of hydrogen when treated with nascent hydrogen.
2. The dihydride thus formed passes over easily into an anhydride by losing one molecule of water.
3. The anhydride of diethyl-curcumin dihydride is much less easily attacked by oxidising agents than diethyl-curcumin, but the products are the same—ethylvanillic acid with a trace of ethylvanillin.
4. Bromine removes two atoms of hydrogen from the dihydride, and replaces four more, forming $C_{14}H_{10}Br_4O_4$.
5. Only four atoms of bromine can be added to curcumin.
6. The tetrabromide has a great tendency to form vanillin when treated with substances which remove bromine.
7. With an excess of bromine a substance, $C_{14}H_9Br_7O_4$, is formed.
8. The pentabrom-curcumin-dibromide is oxidised in neutral or acid solutions only with great difficulty.

The observations just described throw some light upon the nature of the side-chain of curcumin, but as the inferences to be drawn from them are at best extremely doubtful, we shall postpone all discussion of the structure of curcumin until our further study of it has put the subject on a more secure basis.—*Amcr. Chem. Journ.*

Nickel Crucibles.—M. Mèrmet recommends the use of nickel crucibles instead of silver, in chemical manipulations. They are slightly attacked, it is true, by melted potash, but silver itself is not indifferent to this action. They cost at first much less than silver, and moreover they have the great advantage of melting at a higher temperature. It often happens, in fact, that inexperienced chemists melt their silver crucibles in heating them over a gas lamp; such an accident is not to be feared with nickel crucibles.—*Chron. Industr.*

ON COPPER SULPHIDE IN A COLLOIDAL CONDITION.

By W. SPRING.

H. SCHULZE has recently published in the *Journal für Prakt. Chemie* an interesting memoir on soluble antimony trisulphide in which it is said that perhaps other sulphides will prove to be soluble. The author having to prepare pure sulphides and oxides which were needed in an investigation with which he is engaged, had opportunity to observe that several of these bodies can easily be obtained in a colloidal state. The observations of Schulze concerning the solubility of antimony and arsenic trisulphide in pure water completely agree with the author's results.

He finds further that copper sulphide is readily and completely soluble in pure water on proceeding as follows:—

A dilute solution of copper sulphate in ammonia is treated with a current of sulphuretted hydrogen until all the copper is thrown down as sulphide. The black precipitate is then washed by decantation for some weeks with sulphuretted hydrogen-water. As soon as ammonium sulphate or hydrosulphate is no longer present in the washings the sulphide passes gradually into solution and there is ultimately obtained a black liquid with a slight greenish fluorescence. This black liquid passes like water through a filter. On examining it in a stratum of 2 c.m. in depth the colour appears brown, and the presence of suspended copper sulphide cannot be admitted, the solution is clear. This solution can be boiled without decomposition, and if gently evaporated on the water-bath the sulphide is left as a black varnish. Small quantities of solutions of salts quickly cause the black liquid to coagulate especially in heat.

Precipitated copper sulphide which is thus readily taken up by water in the colloidal state loses this property even if dried in a vacuum at common temperatures. The author adds that the pure, dry, copper sulphide thus obtained is not black, as generally asserted, but a fine dark green. If submitted to a pressure of 6500 atmospheres it forms blocks of a deep blue, metallic lustre.

Manganese peroxide obtained by treating manganous hydroxide with hypochlorous acid, passes, when perfectly washed, into a deep brown solution.

The behaviour of antimony trioxide, tin oxide, and tin sulphide, is similar.

The author has obtained more than 50 grms. of this body as a reddish-brown, transparent, vitreous mass by evaporation in a vacuum over sulphuric acid.—*Berichte der Deutsch. Chem. Gesell.*

NEW METHOD FOR THE DETERMINATION OF NITROGEN.

By J. KJELDAHL

THE author shows the desirability of a process for effecting the determination of nitrogen in the moist way. He criticises the process of Wanklyn and Chapman, and proposes in its stead an oxidation in an acid solution.

The sample to be operated upon is first strongly heated with sulphuric acid; and is thus almost invariably brought into such a state that its nitrogen is completely converted into ammonia by the following operation. The principle of the process is treatment with a sufficiency of concentrated sulphuric acid at a temperature not much below the boiling-point of the acid. The solution thus obtained is oxidised with an excess of dry powdered permanganate. Under these circumstances the organic nitrogen is completely transformed into ammonium sulphate; the liquid is then supersaturated with soda, distilled off and determined according to the usual methods.

It is essential for this process that ammonium sulphate, at the high temperature applied, and especially during the subsequent treatment with permanganate, which is attended with a very violent reaction, does not undergo decomposition. This the author has ascertained by special experiments.

The procedure may be described as follows:—The substance is weighed into a small, tared boiling flask, in which the further treatment is to take place.

Even with solids this is a very convenient arrangement, but still more so with liquids. A liquid is weighed in, the water allowed to fly off in the evaporation niche, when the extract remains where it is wanted. Oil of vitriol is then added in a sufficient excess. The quantity may vary within tolerably wide limits, though the author always employs 10 c.c. Great care must be taken that the acid does not absorb ammonia. The author has often found traces of nitrogen in the so-called pure acid of commerce, for which a small correction must be made.

The flask is then placed upon a piece of wire-gauze over a small gas-flame. As a rule the contents become black and tarry, but on continued heating a brisk reaction sets in with escape of gas, during which the substance is completely dissolved. On account of the escape of sulphurous acid and of white fumes this operation should be conducted under a draught-hood. To prevent loss by spirting the flask should be set in a slanting position until the contents are come to rest. The flask should hold about 100 c.c. and have a long narrow neck. When the escape of gases has ceased the action of the sulphuric acid is not at an end; a slow oxidation goes on; the liquid first becoming a deep brown then light brown, yellow, and ultimately clear as water. To accelerate this process a little fuming sulphuric acid or phosphoric anhydride is added. With these additions a heating for two hours is sufficient to give a clear light brown liquid. With the albumenoids and their derivatives the formation of ammonia is as complete after heating for 1-2 hours as if the liquid had been rendered almost colourless by prolonged treatment. With other substances, such as are mentioned below, the addition of phosphoric anhydride is recommended, and heat is applied until the disappearance of the colour indicates that the action of the acid is at an end. The temperature should be a little below the boiling-point of the acid, as is indicated by occasional "bumps." At temperatures of 100°–150° the formation of ammonia is exceedingly imperfect. The substances for analysis do not require pulverisation further than is needed for obtaining a correct average portion.

The oxidation is then effected by means of permanganate, for which no efficient substitute has been found. It is applied in the state of a fine, dry powder, which is introduced in very small portions which may quickly follow each other. The oxidation is effected in the hot liquid, though the flame is removed, and is completed in less than a minute. Although the reaction is violent and is even accompanied with small flames, there is never a loss of ammonia. The completion of the process is indicated by the appearance of a green colour. The author generally allows the flask to stand over a very gentle flame for 5 to 10 minutes, without ascribing especial importance to this procedure. On no account must a strong heat be applied to the green liquid, as this would involve a serious loss of ammonia.

The liquid when sufficiently cool is diluted with water, when the green colour changes to a brown. When again cool it is introduced into the distillatory apparatus, which should hold about $\frac{3}{4}$ litre, and is connected with a top-piece sloping upwards to ensure the reflux of any spirits, and connected with a spiral condenser leading into an absorption apparatus charged with standard acid.

The soda-lye used has the spec. grav. 1.30, of which 40 c.c. are rapidly introduced into the distillatory apparatus and the stopper re-inserted. There is no perceptible loss of ammonia in this operation, and consequently no special arrangement is necessary for the introduction of the alkali.

To prevent bumping in distillation, which would render the operation simply impracticable, small zinc turnings or filings are introduced before the addition of the alkali. The slight evolution of hydrogen gas which they occasion enables the steam to be given off quite easily.

For substances containing about 1.5 per cent of nitrogen the author operates on 0.7 gm.; for richer bodies $\frac{1}{4}$ gm. The results obtained by the new method agree very closely with theory and also with the figures obtained by Will and Varrentrapp's process. In connection with this process the author has obtained good results in the analysis of the alkaloids by omitting, as usually recommended, to form a channel extending along the entire combustion tube by gentle rapping. He considers that the danger of loss by the formation of nitrogenous vapours, which are not taken up by the acid, is greater than that of the dissociation of ammonia which is so often brought forward. For further security he adds a little pure sugar to the soda-lime at the front end of the tube. Whilst the soda-lime sinks together when heated and leaves an open way between itself and the sides of the tube, the sugar on combustion forms a porous carbonaceous mass which fills the entire width of the tube and through which all the gases formed by the combustion of the substance are obliged to pass.

The author, when recommending his method for organic substances in general, with a certain reserve as regards some alkaloids, admits those bodies as exceptional in which the nitrogen occurs in the form of volatile acids, such as, generally speaking, the cyanides and the oxides of nitrogen. As regards the nitrates a peculiar fact must be put on record. Whilst it might be expected that the nitric acid would be in great part volatilised by heating for hours with concentrated sulphuric acid in large excess it is found on the contrary that the greater part of the nitric acid in presence of organic matter is converted into ammonia.—*Zeitschrift Analyt. Chemie.*

DETERMINATION OF IRON BY MEANS OF PERMANGANATE IN A HYDROCHLORIC SOLUTION.

By J. KRUTWIG and ALB. COCHETEUX.

THE injurious influence of hydrochloric acid in the titration of solutions containing ferrous salts by means of Margueritte's process was first pointed out in 1861 by Löwenthal and Lenssen. The importance of the method led Fresenius and others to search for means of obviating the disturbing action of hydrochloric acid. Some time ago there appeared in the *Berichte* a memoir on the same subject by Clemens Zimmermann. He recommended an addition of manganese sulphate to the hydrochloric solution. The authors have tried this method in many determinations of iron ores, and obtained accurate results so that they can recommend the use of manganese sulphate. It seemed remarkable, however, that determinations of iron which they had formerly made had likewise given figures analytically correct. They believe that the cause of this was that they dissolved the iron ore in the smallest possible quantity of hydrochloric acid (10 c.c. to 0.1 gm. of ore), adding then 400 c.c. water and about 30 c.c. sulphuric acid. Special experiments seem to justify this supposition. The use of sulphuric acid keeps down the discrepancies in the results, so that there is no objection to the use of Margueritte's process in presence of hydrochloric acid if the following precautions are observed:—

1. If possible dissolve the ore in very little sulphuric acid.
2. Reduce by means of zinc in the hydrochloric solution.

3. Add a quantity of sulphuric acid twice as great as that of the hydrochloric acid.
4. Dilute the solution to about 300 c.c.
5. Use dilute permanganate in titration.

—*Berichte Deutsch. Chem. Gesell.*

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY
SAMPLES OF THE WATER SUPPLIED TO LONDON
FOR THE MONTH ENDING JULY 31ST, 1883.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
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and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London
Hospital; Medical Officer of Health for Islington.

To the Water Examiner, Metropolis Water Act, 1871.

London, August 7th, 1883.

SIR,—We beg to submit to you a statement of the results of our examination of the 182 samples of water collected by us during the month of July, at the times and places indicated, from the mains of the seven London companies taking their supply from the Thames and the Lea; together with some remarks on the character of the supply during the preceding month.

Our examinations are made, as you are aware, under instructions from the Water Companies; the collection of samples, however, as well as the methods of analysis and the form of publication of the results, being left entirely to ourselves, the Companies taking no part in the matter beyond bearing the expenses.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from July 2nd to July 31st inclusive. The purity of the water, in respect of organic matter, has been determined by the Oxygen and the Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples submitted for analysis.

Of the 182 samples of water submitted to examination the whole without exception were clear, bright, and well filtered. In respect to aëration, and to general freedom from colour and excess of organic matter, they have maintained their excellent character; although, indeed, in one exceptional sample, the proportion of organic matter present was in excess of what is customary at this season of the year.

In our last monthly report we stated that "Of the 182 samples of water submitted to examination (including 26 samples of the Grand Junction Company's water), the whole, without exception, were clear, bright, and well filtered." We observe that your own official statement with regard to the Grand Junction Company's supply during the month of June is as follows:—"Daily samples were taken at the works, and the water found to be clear, bright, and efficiently filtered." But in Dr. Frankland's report to the Registrar-General it is stated that, "With the exception of the Grand Junction Company's water, which was very slightly turbid, all the water was efficiently filtered," this statement as to the character of the Grand Junction supply "during the month of June" being based on the examination of a single sample of the Company's water taken on the 19th day of the month. Since the publication of this report to the Registrar-General we have examined afresh a reserved duplicate sample of the Grand

Junction Company's water, drawn by us on the 19th day of the month, and again found it to be clear, bright, and well filtered.

Elsewhere, in the same report to the Registrar-General, it is stated that the river-derived waters supplied to London in June contained from nearly 2 to $2\frac{3}{4}$ times as much "organic impurity" as a certain well-water standard, peculiar to the reporter. As usual, it is not thought advisable to point out that measured by the same peculiar standard, the "organic impurity" of the highly-reputed Loch Katrine water supplied to Glasgow is, according to the reporter's own figures, in excess of that present in the Grand Junction, Chelsea, West Middlesex, Lambeth, and East London Companies' waters, and is double that present in the New River Company's water.

We would renew our protest against the use of this misleading scale of implied unwholesomeness, and the partizan purposes it is skilfully made to subserve,—a protest especially called for at the present time, when the possible spread of cholera from Egypt to the United Kingdom has directed unusual attention to questions of water-supply, and more particularly to the supply of the Metropolis. Now, either this supply is wholesome and suitable, as well during periods of epidemic as at other periods, or it is unwholesome and therefore unsuitable. The present sources, if unwholesome, ought clearly to be abandoned, at almost any cost. But if these sources, from which water has been supplied continuously to the largest and one of the healthiest among great cities, are determined by competent and impartial authority to be wholesome, it would seem scarcely fitting that an official reporter, whatever the earnestness of his personal convictions, should, by appealing to an arbitrary scale of his own invention, and with the object of enforcing his own individual view, subject these sources to persistent disparagement; and thereby create the unfounded alarms that were so strongly deprecated by the Royal Commission who last inquired into the water supply of London. The public ought persistently to bear in mind, and make due allowance for the fact, that the monthly reports to the Registrar-General are furnished by a chemist eminently hostile to the present riverian supply; and one whose views and startling modes of statement were alike dis- countenanced by the late Royal Commission, when having his reports and evidence under consideration.

We are, Sir,
Your obedient Servants,
WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.
Chief Chemist to the U.S. Geological Survey, Washington.

CARBON.

ALTHOUGH there is a large mass of material relating to the atomic weight of carbon, much of it may be summarily set aside as having no value for present purposes. The density of carbon dioxide, which has been scrupulously determined by many investigators,† leads to no safe estimate of the constant under consideration. The numerous analyses of hydrocarbons, like the analyses of naphthalene by Mitscherlich, Woskresensky, Fownes, and Dumas, give results scarcely more satisfactory. In short, all the work

done upon the atomic weight of carbon before the year 1840 may be safely rejected as unsuited to the present requirements of exact science. As for methods of estimation we need consider but three, as follows:—

First.—The analysis of organic salts of silver.

Second.—The determination of the weight of carbon-dioxide formed by the combustion of a known weight of carbon.

Third.—The method of Stas, by the combustion of carbon monoxide.

The first of these methods, which is also the least accurate, was employed by Liebig and Redtenbacher* in 1840. They worked with the acetate, tartrate, racemate, and malate of silver, making five ignitions of each salt, and determining the percentage of metal. From one to nine grms. of material were used in each experiment.

In the acetate the following percentages of silver were found:—

64.615
64.624
64.623
64.614
64.610

Mean 64.6172 \pm 0.0018

After applying corrections for weighing in air this mean becomes 64.6065.

In the tartrate the silver came out as follows:—

59.297
59.299
59.287
59.293
59.293

Mean 59.2938 \pm 0.0014

Or reduced to a vacuum 59.2806.

In the racemate we have:—

59.290
59.292
59.287
59.283
59.284

Mean 59.2872 \pm 0.0012

Or, corrected, 59.2769.

And from the malate:—

61.996
61.972
62.015
62.059
62.011

Mean 62.0106 \pm 0.0006

Or, corrected, 62.0016.

Now, applying to these mean results the atomic weights already found for oxygen and silver, we get the following values for carbon:—

From the acetate	C = 12.0306 \pm 0.0047
„ tartrate	„ = 12.0356 0.0064
„ racemate	„ = 12.0413 0.0063
„ malate	„ = 12.0408 0.0054

General mean „ = 12.0363 \pm 0.0028

Now these results, although remarkably concordant, are by no means unimpeachable. They involve two possible sources of constant error, namely, impurity of material and the volatility of the silver. These objections have both

* Smithsonian Miscellaneous Collections. "The Constants of Nature."

† Notably by Lavoisier, Biot and Arago, De Saussure, Dulong and Berzelius, Buff, Von Rede, Regnault, and Marchand. For details, Van Geun's monograph may be consulted

* Ann. Chem. Pharm., 38, 137. Mem. Chem. Soc., 1, 9. Phil. Mag., (3), 19, 210.

been raised by Stas, who found that the silver tartrate, prepared as Liebig and Redtenbacher prepared it, always carried traces of the nitrate, and that he, by the ignition of that salt, could not get results at all agreeing with theirs. In the case of the acetate a similar impurity would lower the percentage of silver, and thus both sources of error would reinforce each other and make the atomic weight of carbon come out too high. With the three other salts the two sources of error act in opposite directions, although the volatility of the silver is probably far greater in its influence than the impurity. Even if we had no other data relating to the atomic weight of carbon, it would be clear from these facts that the results obtained by Liebig and Redtenbacher must be decidedly in excess of the true figure.

A different method of dealing with organic silver salts was adopted by Maumené,* in 1846, for the purpose of establishing, by reference to carbon, the atomic weight of silver. We will simply reverse his results and apply them to the atomic weight of carbon. He effected the combustion of the acetate and the oxalate of silver, and, by weighing both the residual metal and the carbon dioxide formed, he fixed the ratio between these two substances. In the case of the acetate his weighings show that for every gram. of metallic silver the weights of CO₂ were produced, which are shown in the third column:—

8.083	gram. Ag =	6.585	gram. CO ₂ .	0.8147
11.215	"	9.135	"	0.8136
14.351	"	11.6935	"	0.8148
9.030	"	7.358	"	0.8148
20.227	"	16.475	"	0.8145

Mean 0.81448

The oxalate of silver, ignited by itself, decomposes too violently to give good results; and for this reason it was not used by Liebig and Redtenbacher. Maumené, however, found that when the salt was mixed with sand the combustion could be tranquilly effected. The oxalate employed, however, with the exception of the sample represented in the last experiment of the series, contained traces of nitrate, so that these results involve slight errors. For each gram. of silver the appended weights of CO₂ were obtained:—

14.299	gram. Ag =	5.835	gram. CO ₂ .	0.4081
17.754	"	7.217	"	0.4059
11.550	"	4.703	"	0.4072
10.771	"	4.387	"	0.4073
8.674	"	3.533	"	0.4073
11.4355	"	4.658	"	0.4073

Mean 0.40718

Now, one of these salts being formed by a bivalent and the other by a univalent acid, we have to reduce both to a common standard. Doing this, we have the following results for the ratio between the atomic weight of silver and the molecular weight of CO₂; if Ag = 100.

From the acetate, CO₂ = 0.40724 ± 0.000076
 ,, oxalate ,, = 0.40718 0.000185

General mean ,, 0.40723 ± 0.000071

Here the slight error due to the impurity of the oxalate becomes of such trifling weight that it practically vanishes.

From these data if Ag = 107.675 ± 0.0096, CO₂ = 43.8485 ± 0.0086.

Hence C = 11.9219 ± 0.0111.

As has already been said the volatility of silver renders all the foregoing results more or less uncertain. Far better figures are furnished by the combustion of carbon directly, as carried out by Dumas and Stas† in 1840 and by Erdmann and Marchand‡ in 1841. In both inves-

tigations weighed quantities of diamond, of natural graphite, and of artificial graphite were burned in oxygen and the amount of dioxide produced was estimated by the usual methods. The graphite employed was purified with extreme care by treatment with strong nitric acid and by fusion with caustic alkali. I have reduced all the published weighings to a common standard, so as to show in the third column the amount of oxygen which combines with a unit weight (say one gram.) of carbon. Taking Dumas and Stas' results first in order we have from natural graphite:—

1.000	gram. C gave	3.671	gram. CO ₂ .	2.6710
0.998	"	3.660	"	2.6673
0.994	"	3.645	"	2.6670
1.216	"	4.461	"	2.6686
1.471	"	5.395	"	2.6676

Mean 2.6683 ± 0.0005

With artificial graphite:—

0.992	gram. C gave	3.642	gram. CO ₂ .	2.6714
0.998	"	3.662	"	2.6682
1.660	"	6.085	"	2.6654
1.465	"	5.365	"	2.6744

Mean 2.66985 ± 0.0013

And with diamond:—

0.708	gram. C gave	2.598	gram. CO ₂ .	2.6695
0.864	"	3.1675	"	2.6661
1.219	"	4.465	"	2.6628
1.232	"	4.519	"	2.6680
1.375	"	5.041	"	2.6662

Mean 2.6665 ± 0.0007

Erdmann and Marchand's figures for natural graphite give the following results:—

1.5376	gram. gave	5.6367	gram. CO ₂	2.6659
1.6494	"	6.0384	"	2.6609
1.4505	"	5.31575	"	2.6647

In one experiment 1.8935 gram. of artificial graphite gave 6.9355 gram. CO₂. Ratio for O, 2.6628. This, combined with the foregoing series, gives a mean of 2.6636 ± 0.0007.

With diamond they found:—

0.8052	gram. gave	2.9467	gram. CO ₂ .	2.6596
1.0858	"	3.9875	"	2.6632
1.3557	"	4.9659	"	2.6629
1.6305	"	5.97945	"	2.6673
0.7500	"	2.7490	"	2.6653

Mean 2.6637 ± 0.0009

Now, combining all these series, we get the following result:—

Dumas and Stas, 1st set	..	2.6683	± 0.0005
2nd ,,	..	2.66985	0.0013
3rd ,,	..	2.6665	0.0007
Erdmann and Marchand, 1st..	..	2.6636	0.0007
2nd ..	..	2.6637	0.0009

General mean 2.66655 ± 0.0003

Hence, if O = 15.9633 ± 0.0035, C = 11.973 ± 0.0030.

Another very exact method for determining the atomic weight of carbon was employed by Stas* in 1849. Carefully purified carbon monoxide was passed over a known weight of copper oxide at a red heat, and both the residual metal and the carbon dioxide formed were weighed. The weighings were reduced to a vacuum standard, and in each experiment a quantity of copper oxide was taken representing from eight to twenty-four grammes of oxygen. The method, as will at once be seen, is in all essential features similar to that usually employed for determining

* *Ann. de Chim. et de Phys.* (3), 18, 41.

† *Comptes Rendus*, 11, 991-1008. *Ann. Chim. Phys.* (3), 1, 1.

‡ *Journ. f. Prakt. Chem.*, 23, 150.

* *Bull. Acad. Bruxelles*, 1849 (1), 31.

the composition of water. The figures in the third column, deduced from the weights given by Stas, represent the quantity of carbon monoxide corresponding to one gramme of oxygen:—

9.265	grms. O = 25.483	CO ₂	1.75046
8.327	„ 22.900	„	1.75010
13.9438	„ 38.351	„	1.75040
11.6124	„ 31.935	„	1.75008
18.763	„ 51.6055	„	1.75039
19.581	„ 53.8465	„	1.74994
22.515	„ 61.926	„	1.75043
24.360	„ 67.003	„	1.75053

Mean 1.75029 ± 0.00005

Hence the molecular weight of carbon monoxide is 27.9404 ± 0.0062. And C = 11.9771 ± 0.0071.

Now, in order to complete our discussion, we must combine the four values we have found for carbon:—

1. By Liebig and Redtenbacher .. C = 12.0363 ± 0.0028
2. By Maumené's figures „ 11.9219 0.0111
3. By combustion of carbon „ 11.9730 0.0030
4. By Stas's method „ 11.9771 0.0071

General mean „ 12.0021 ± 0.0019

But values one and two are hardly reliable enough to be included in our final estimate. They involve dangerous constant errors, and ought, therefore, to be disregarded. Rejecting them altogether, and taking a general mean from values three and four, we get for the most probable figure for the atomic weight of carbon, C = 11.9736 ± 0.0028. If oxygen is 16, then carbon becomes 12.0011. In other words, the ratio between oxygen and carbon is almost exactly 16 to 12.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin.
Vol. 16, No. 1.

Formation of Dibrom-dinitro-methan and of the Tetra-nitro-ethylen-bromide of Villiers.—S. M. Losanitsch.—These two compounds are identical.

Sequel to a Communication on the Action of Concentrated Sulphuric Acid upon Dinitro-anthraquinone.—C. Liebermann.—This memoir does not admit of useful abstraction.

History of the Cuprea-Barks.—O. Hesse.—A pharmacological paper.

Occurrence of Large Crystals of Magnesium-ammonium Phosphate in Human Urine.—H. Weiske.—In a specimen of very acid urine which had been kept for four months, and had deposited a sediment of ammonium urate, well-developed crystals of the magnesium-ammonium phosphate were found.

Action of Chloro-cyanogen on the Potassium Compound of Pyrrol.—G. L. Ciamician and M. Dennstedt.—The result of the reaction is tetrol-cyanuramid, C₄H₄N ... CN.

Action of Red Fuming Nitric Acid upon Acetacetic Ether and Mono-chlor-acet-acetic Ether.—Max Pröpper.—The author considers that the bodies which he obtained by this reaction are not nitroso-, but oximido-compounds.

A New Class of Colouring-Matters.—E. Besthorn and O. Fischer.—The authors have previously made

known that certain acetyl-compounds of aromatic bases if exposed to the action of dehydrating agents at high temperatures, form a group of new colouring-matters, of which flavoline, C₁₆H₁₃N, serves as the type. In the present paper the author describes some of its derivatives, such as flavaniline (mono-amido-flavoline), mono-nitro-flavoline, flavenol, &c. The last-mentioned compound is obtained by dissolving flavoline in an excess of hydrochloric acid, diluting largely with water, treating with sodium nitrite, and, after boiling, mixing with concentrated hydrochloric acid. Amongst the oxidation-products of flavenol is described picolin-tricarboxylic acid.

Vol. 16, No. 2.

Certain Aromatic Amines.—Ernst Louis.—The author has studied amido-propyl-benzol, its sulphate, oxalate, and acetyl-compound, benzoyl-amido-propyl-benzol, a bi-propylised aniline, propyl-phenol, its iodide; amido-iso-propyl-benzol, its sulphate and oxalate benzoyl compound, a secondary iso-propyl base, iodo-iso-propyl-benzol, and he finally examines the iso-butylation of aniline.

Activation of Oxygen by Nascent Hydrogen.—F. Hoppe-Seyler.—The author maintains, in opposition to H. Traube, that nascent hydrogen in presence of oxygen gas occasions energetic oxidation.

Fermentation of Cellulose.—F. Hoppe-Seyler.—The author proves that cellulose in sewage deposits is decomposed by ferments into a mixture of carbonic acid and methane. A small percentage of free hydrogen is also present, whence it follows that organic compounds have been formed containing a lower proportion of oxygen and hydrogen than occurs in cellulose.

Activation of Oxygen.—M. Traube.—The author discusses at length the oxidation of carbon monoxide by palladium hydride and oxygen, and the activation of oxygen by palladium. He considers the following bodies only as capable of activating oxygen:—The precious metals, especially those of the platinum group, copper oxide in certain solutions, the alkalis (in comparatively rare cases), and phosphorus. All these bodies, except phosphorus, are indifferent towards oxygen at common temperatures, even in presence of water. Phosphorus is certainly autoxidizable, but, like palladium-hydride, it does not activate oxygen by its autoxidation. Phosphorus is the only autoxidisable body which yields ozone.

Transformation of Acetacetester into Succinylsuccinic Ester or respectively Hydroquinone.—C. Duisberg.—Not suitable for abstraction.

Combustion of Sulphur with a White Phosphorescent Flame.—K. Heumann.—The author raises the question whether sulphur, selenium, arsenic, &c., are not, under suitable circumstances, capable of phosphorescing like phosphorus. He finds that when sulphur is heated on a metal or porcelain plate in the dark, the vapours suddenly become phosphorescent, burn with a bluish grey flame, perfectly distinct from the ordinary fine blue flame of sulphur. The odour given off is not that of sulphurous acid, but resembles that of hydrogen persulphide, camphor, and ozone. The product of the combustion is doubtless a stage of oxidation lower than sulphurous anhydride.

Certain Isothiamides and the Amidines obtained from them.—O. Wallach and M. Wüsten.—Proceeding from thio-formanilide the authors obtain ethyl-iso-thio-formanilide.

Use of Potassium Bisulphate as a Condensation-Agent.—O. Wallach and M. Wüsten.—The authors point out the disadvantages of sulphuric acid and of zinc chloride, the agents most in use, and recommend potassium bisulphate, which they have used with success in a number of cases, some of which are here described.

Specific-heat and Valence of Thorium.—L. F. Nilson.—The author concludes from his experiments that

if the law of Dulong and Petit is to apply to the specific-heat of thorium as determined, the quadrivalence of the metal follows of course, since its atomic-heat ($\text{Th}''' = 232.4$) is then perfectly normal $= 6.4$. It may therefore be regarded as finally proved that thorium must rank among the quadrivalent elements, its only known oxide being regarded as ThO_2 . Prof. Nilson gives the following summary of its agreement with quadrivalent elements:—

1. Atomic heat for $\text{Th}''' = 6.4$.
2. Atomic volume $= 20.94$, in accord with zirconium, cerium, lanthanum, and didymium.
3. Crystalline form of thorium; isomorphous with silicium.
4. Crystalline form of thorium oxide; isomorphous with stannic oxide, zirconia, titanium oxide.
5. Crystalline form of thorite; isomorphous with zircon.
6. Molecular volume of thorium oxide; accordance with CeO_2 , UO_2 .
7. Molecular heat of thorium oxide; accordance with ZrO_2 , ZrSiO_4 , CeO_2 , SnO_2 , MnO_2 .
8. Atomic heat of the oxygen in thorium oxide; accordance with the same compounds.
9. Composition of thorium double fluorides.
10. Composition of the platinum chloride; accordance with tin and zirconium.
11. Thorium forms with platinum a very fusible alloy; accordance with silicium.

Synthesis of Cinnamic Acid according to T. Swarts.—E. Erlenmeyer.—The acid which Swarts took for cinnamic acid, seems to have been phenyl-propionic acid.

Ortho-nitro-cinnamyl-acetacetic Ether.—E. Fischer and H. Kuzel.—An account of acetonyl-quinoline, of the reduction of ortho-nitro-cinnamyl-acetacetic ether, and of cinnamyl-acetacetic ether.

Isonitroso-Compounds.—V. Meyer.—A discussion of the constitution of acetoxim.

Acetoxims.—Alois Janny.—The author has studied the splitting up of acetoxim by the action of acids; its behaviour with acetic anhydride, acetyl chloride, benzoyl chloride, and phosphorus pentoxide. He describes, further, acetoxim hydrochlorate, the sodium derivative of acetoxim, the benzyl compound, and benzyl-hydroxylamine.

Isonitroso-ketones.—C. Schramm.—An account of isonitroso-methyl-acetone and of ethyl-methyl-acetoximic acid.

Acetoximic Acids.—C. Schramm.—The author has obtained two further homologues of the acetoximic acid, described by V. Meyer and A. Janny.

Oxygen Acids of Chlorine.—C. W. Blomstrand.—A reply to W. Spring, who asserts that in the acids of chlorine the chlorine atoms possess identical functions and properties.

Sulphaminic and Oxy-acids derived from Pseudo-cumol.—Oscar Jacobsen and H. Meyer.—The authors describe sulphamin-xylic acid, sulphamin-xylidinic acid, oxy-xylidinic acid, and oxy-trimellitic acid.

Amido-meta-xylo-sulphonic Acid, 1, 3, 4, 6.—Oscar Jacobsen and H. Ledderboge.—In order to separate the bases present in commercial xyloidine in the form of sulphonic acids the authors have treated xyloidine from two different sources with sulphuric acid. They obtained essentially only a single amido-xylo-sulphonic acid, which appears derived from 1, 3, 4 meta-xyloidine. A second acid distinguished by its less soluble and more readily crystalline barium salt was not found at all in the one case, and was present in the other in too small quantities to admit of nearer examination.

Para-xanthine, a New Constituent of Normal Human Urine.—G. Salomon.—Para-xanthine has the composition $\text{C}_{15}\text{H}_{17}\text{N}_9\text{O}_4$; it forms colourless crystals of a vitreous lustre, containing no crystalline water. It is insoluble in alcohol and ether, and dissolves much more

readily in hot than in cold water. It is evidently closely allied to guanine, xanthine, and hypo-xanthine.

Determination of Sulphurous Acid in Wine.—V. Wartha.—The author maintains the accuracy of his method, which consists in adding solution of silver nitrate to the distillate of the wine, and inferring the presence of sulphurous acid from a white precipitate, soluble in nitric acid.

Action of Quinoline upon Chloroform and Iodoform.—O. Rhoussopoulos.—With chloroform the reaction takes place at temperatures above 300° , but with iodoform at ordinary temperatures. In the latter case the product is methan-trichinoil-hydriodate.

Glycocolls, Glycollic Ethers, and Oxethylenures of the Toluyll and Xylyl Series.—A. Ehrlich.—We find here an account of ortho-toluyll-glycocoll-toluidide and of xylyll-glycocoll.

Aldehyd-ammonium Bases.—G. Meyer.—The author's object in these researches is to determine the constitution of muscarine.

Action of Trimethylen-bromide upon Sodium Acetacetic Ether.—W. H. Perkin, jr.—The author obtains a compound of the composition $\text{C}_9\text{H}_{14}\text{O}_3$, having the vapour-density 6.21, and a corresponding acid, $\text{C}_7\text{H}_9\text{O}_3$.

The Condensation-Products of Cœnanthol.—W. H. Perkin, jr.—The author has studied the oxidation of the aldehyd $\text{C}_{14}\text{H}_{26}\text{O}$, and the action of potassium hydrate upon $\text{C}_{14}\text{H}_{26}\text{O}$.

— — —
Cosmos les Mondes.

Tome v., No. 13, July 28, 1883.

A New Substance Sensitive to Light.—Dr. D. Tommasi.—Anthracene, after exposure to light, acquires different physical and chemical properties without any change in its composition. If a cold, clear, saturated solution of anthracene in benzol is exposed to the direct rays of the sun, it becomes turbid and deposits crystals. This photogenic substance is a polymer of anthracene, and has received the name paranthracene. If melted, it is suddenly re-converted into anthracene.

Prof. Fittig is said to have obtained a sulphur acid as a very stable powder, insoluble in water.

[Dr. Tommasi credits these paragraphs to the *Photographic News* and the *Revue Scientifique*.]

— — —
Biedermann's Central-Blatt für Agrikultur-Chemie,
Vol. xii., Part 7.

Self-Purification of Streams contaminated by Drainage from Peat-Bogs.—Prof. W. N. Hartley.—An abstract of a paper read before the Society of Arts.

The Keldinger Moor and its Amelioration by Means of Marsh-Soil.—Dr. C. Virchow.—The principal point in this memoir is the notice of a stratum of sub-soil known locally as "mai-bolt," or poison-earth, from its destructive action upon vegetation. It contains abundance of vivianite, iron-ochre, and iron sulphide, and retains its injurious properties, even after exposure to the air for eight to nine years.

Experiments on the Action of Sulphuric Acid as Manure.—Prof. F. Farsky.—A clayey soil was treated with sulphuric acid in the proportion of 100 grms. to 3500 grms. of mould. Another portion received a corresponding dose of the solution of sodium bisulphate. Both were without action upon moist soils, and reduced the yield of a dry soil.

So-called Reversion of Phosphoric Acid in Superphosphates.—Prof. J. Post.—Reversion consists not merely in the precipitation of iron and aluminium phosphates which were originally soluble, but a further part of the phosphoric acid which was soluble at first enters

into reaction with insoluble portions of the superphosphate. A part of the free phosphoric acid enters into combination with iron and aluminium and calcium phosphate is also deposited, probably as double iron and aluminium calcium phosphate.

MISCELLANEOUS.

Cinchona Ledgeriana.—Under this name a species of cinchona has of late years attracted a considerable amount of attention in consequence of its high value in its yield of quinine. In the year 1865 a native servant of Mr. C. Ledger, collected the seed from fifty trees growing, according to the Kew report for 1880, "in the almost inaccessible banks of the River Mamore, in Bolivia, a place to which no botanist has ever approached more nearly than one hundred miles. It was sent to London to the care of Mr. Ledger's brother, who sold half to the Dutch Government for Java, and half to Mr. Money, a cinchona planter on the Nilgiri Hills." "The seed purchased by the Netherlands Government was," continues the Kew Report, quoting from a report made by Dr. Siemens to the Colonial Secretary in Ceylon, "sent to Java, and 20,000 plants were raised from it, a number afterwards reduced to some 6300." This purchase," we read further on, "proved a very fortunate one for the Dutch, and may be said to have infused new life into the flagging cinchona cultivation of Java. Up to the year 1872 the bark sent thence had been almost wholly of inferior quality, but in 1873 it was found that of the new kind afforded eight per cent of alkaloids, of which from $5\frac{1}{2}$ to $6\frac{1}{2}$ was genuine. In 1874 this was greatly exceeded, one sample even reaching a total of 12.97 alkaloids, 11.01 being quinine." To this is appended a note to the effect that Dr. King, of Calcutta, has stated that some of the plants in the Dutch plantations "have yielded on analysis the extraordinary amount of 13.7 per cent of quinine." It is not to be wondered at that a plant so extremely rich in this valuable alkaloid should attract the attention it did at a recent meeting of the Linnean Society, when Mr. J. E. Howard, F.R.S., the best living authority on the subject of cinchona, read a paper on the subject. The question between botanists is whether the plant now generally known as *Cinchona Ledgeriana* is really entitled to rank as a distinct species. Mr. Howard looks upon it as a variety of *C. Calisaya*, while other botanists consider there are characters about it sufficiently strong to let it stand alone as *C. Ledgeriana*. This no doubt is an interesting point for scientists, but those who look to the practical side of the question will consider how best to increase the cultivation in the highest degree of a plant that yields, on the authority of Mr. Howard himself, so high a percentage of quinine as from 7 to 12 on an average. The difficulty hitherto has been to obtain seeds of this valuable plant, and consequently while the demand for it has been great the supply has been extremely limited. Indeed planters have been unable in many cases to obtain the seeds at all. It is satisfactory, therefore, to know that by the energy of Mr. T. Christy, of 155, Fenchurch-street, he has succeeded in obtaining seeds and raising plants in sufficient quantity to supply those interested in the culture. The genuineness of Mr. Christy's plants which he exhibited at the Linnean Society's meeting was verified by Mr. Howard.—*Land and Water*, Aug. 11th.

NOTES AND QUERIES.

* * Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Corrosion of Boilers.—(Reply to "An Old Subscriber.")—The information will be supplied shortly it is hoped.—G.A.K.

ERRATUM.—Page 85, col. 2, line 32 from top, for "low" read "high."

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THE CHEMICAL NEWS.

VOL. XLVIII. No. 1241.

NOTES OF WORK BY STUDENTS OF PRACTICAL CHEMISTRY

IN THE
LABORATORY OF THE UNIVERSITY OF
VIRGINIA.

No. XII.

Communicated by J. W. MALLET,
Professor of General and Applied Chemistry in the University.

(Concluded from p. 98.)

(100.) *Analysis of Topaz from a New Locality in Maine,*
U.S. By C. M. BRADBURY, of Petersburg, Vir-
ginia.

The material for this analysis consisted of large, colourless, topaz crystals, from Stoneham, Maine, sent by Mr. G. F. Kunz, connected with the firm of Tiffany and Co., jewellers, of New York. The occurrence of the mineral, in part in very large crystals, at this locality, was discovered by Mr. Kunz. He reported that in most of his specimens there were numerous cavities, microscopic and large, containing water and liquefied carbon dioxide.

The mineral was transparent to translucent, much fractured in the interior, showing on the outside portions of the principal crystal faces. Specific gravity, taken with one of the largest and most solid pieces, = 3.54.

In the analysis an attempt was made to determine the fluorine by Penfield's method,* but neither by heating with strong sulphuric acid nor with potassium acid sulphate could anything like complete decomposition be effected. Recourse was therefore had to the older method of Berzelius. The mineral was crushed in a steel diamond mortar, avoiding altogether the use of an agate mortar. The powder was washed free of iron by treatment with cold, very dilute hydrochloric acid, and the finest portion separated by elutriation. This finest portion only was then dried, weighed, fused with sodium carbonate, and the fused mass disintegrated by water. The insoluble portion was caught on a filter and well washed, the filtrate and washings digested with ammonium carbonate, the precipitate—of silicic acid and aluminum hydrate and silicate—filtered off, washed, and the last portions of silicic acid separated from the filtrate by evaporation with an ammoniacal solution of zinc, filtering off the zinc silicate. This last was decomposed by evaporation to dryness with nitric acid, the re-dissolved zinc thrown away, and the residue of silica added to that obtained in the usual way from the original residue insoluble in water and from the precipitate formed by ammonium carbonate. The aluminum was determined in the filtrates from silica. The original aqueous solution, having been thus cleared of silicon and aluminum, was treated with calcium chloride, the mixed precipitate of calcium fluoride and carbonate was washed, dried, and ignited, treated with a slight excess of acetic acid, evaporated to dryness on a water-bath, the calcium acetate washed out with water, and the residual fluoride well washed, dried, ignited, and weighed. It was found, in this and two other similar analyses of topaz, that in the calcium fluoride so obtained there was retained a minute amount of alumina, which was separated and determined.

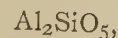
The results were as follows:—

Al	..	..	..	..	..	..	27.14
Si	..	..	..	..	..	..	14.64
F	..	..	..	..	..	..	29.21
O	..	..	..	..	..	..	28.56

99.55

The oxygen being taken as the sum of that in the Al_2O_3 and SiO_2 found, minus the equivalent of the fluorine (one atom of O for two of F).

These results agree very fairly with the well-established formula for topaz—



with fluorine replacing a part of the oxygen, except that the proportion of fluorine is much larger than usual: instead of its taking the place of *one-half* the oxygen corresponding to silicon, it represents pretty accurately *three-fourths* of this.

This remarkable anomaly leads to a question of the correctness of the analysis; and although Mr. Bradbury knew of no ground for suspecting inaccuracy in any part of his work (which was very carefully done), and the summation of the percentage results is satisfactory, it seemed very desirable to secure a repetition of the analysis. The near approach of the close of the working session prevented this. On the whole, it is perhaps well to publish the results obtained, as they may represent an unusual variety of the mineral, though such a conclusion must be looked upon as requiring confirmation.

(101.) *On a Variety of Chrysocolla from Arizona.* By W. C. EUSTIS, of Washington, D.C.

This formed a part of a mass from the Ivanhoe Mine, in Arizona, 80 miles west of Silver City. Most of the specimen consisted of carbonate, but associated with this were two sensibly different varieties of chrysocolla, the one bluish green, more or less translucent, and yielding much less water than the other, which was of a pure emerald-green colour, transparent, with vitreous lustre, and in imperfectly crystalline grains, doubtless pseudomorphous. This last substance was that submitted to analysis. Its specific gravity was 2.3. Hardness = 3.5.

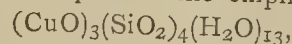
The composition was found to be:—

CuO	..	..	..	..	..	33.22
SiO ₂	..	..	..	..	..	34.08
H ₂ O	..	..	..	..	..	31.65

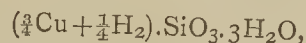
98.95

No traces of other substances could be found, and as the cupric oxide and silica were very accurately determined, the water might perhaps even better be taken by difference than from the direct determination, though this would scarcely change the result.

These figures correspond to the empirical formula,—



or to—



in which we have a partially acid or hydrogen silicate.

The relation to other allied minerals is shown in the following series:—

Diopside	..	..	..	..	..	$\text{CuSiO}_3 \cdot \text{H}_2\text{O}$
Chrysocolla; ordinary	..	..	..	..	..	$\text{CuSiO}_3 \cdot 2\text{H}_2\text{O}$
Ditto; some specimens	..	..	..	..	..	$\text{CuSiO}_3 \cdot 3\text{H}_2\text{O}$
Ditto; mineral now described	..	..	..	..	..	$(\frac{3}{2}\text{Cu} + \frac{1}{2}\text{H}_2) \cdot \text{SiO}_3 \cdot 3\text{H}_2\text{O}$

(102.) *Determination of the Alkaline Metals in a Lepidote from India.* By M. PAGE, of the University of Virginia.

The lepidolite in question came from Pihra-Hazáribágh—Chutia Nagpur—Bengal, and was sent me by my brother, Mr. F. R. Mallet, of the Geological Survey of India, who has described* the conditions under which the mineral occurs. It is found in granite, in irregular

* *Amer. Chem. Jour.*, April, 1879, p. 27.

* "Records of the Geological Survey of India," vii., pt. I., p. 43

masses, and of two varieties, the one a violet-red in colour, the other a lead-grey, both associated with quartz, and occasionally enclosing small black grains and crystals of tinstone.

An analysis, by Mr. Tween, of the violet-red variety is reported* as follows:—

Silica	50.39
Alumina	31.63
Oxide of manganese .. .	trace
Lithia	3.71
Potash	1.40
Soda	5.80
Fluorine	5.00
Loss on ignition .. .	4.23
	<hr/> 102.16

The loss on ignition clearly ought not to be added to the sum of the ingredients found unless they were determined from the ignited residue, since the loss at any rate includes silicon fluoride. These results differ widely from those of all previous analyses of lepidolite as regards the proportions in which the alkaline metals occur, much more sodium and less potassium than usual being present, while no reference is made to the presence or absence of the rarer metals, caesium, rubidium, and thallium.

Mr. Page undertook to examine the alkaline ingredients of my specimen, which, however, represented the dark lead-grey variety, without any tint of violet. A large quantity (102 grms.) of the mineral was used, and was decomposed by fusion with a mixture of ammonium chloride and a natural calcium carbonate, the minute amount of alkali (potassium and sodium) in which had been previously very accurately determined. The mixed alkaline chlorides, freed from all other substances, were digested for a long time in alcohol of 90 per cent, the insoluble residue separated and washed with alcohol of the same strength until no lithium could be detected in the washings by means of the spectroscope. The residue was then dissolved in water, the solution freed from alcohol by heat, a definite fraction of the whole evaporated to dryness, and the sum of the alkaline chlorides present ascertained, this re-dissolved, potassium and rubidium thrown down by platinum chloride, freed from sodium by treatment with 86 per cent alcohol, and the sum of the two double salts determined, the sodium being obtained by difference. The rest of this main watery solution was then used to determine rubidium alone by fractional precipitation with platinum chloride, and washing with boiling water as often as twenty times, *i.e.*, several times after but mere traces of potassium could be detected in the washings with the aid of the spectroscope. In the original alcoholic solution a little potassium was determined in one fraction as platino-chloride, the lithium in another fraction as phosphate, and a minute amount of sodium by difference, the sum of all the chlorides having been got by evaporation.

Subtracting the known and extremely small quantities of alkaline metals derived from the limestone used, calculating those of the lepidolite as monoxides (the form most commonly reported), and stating the results as for 100 parts of the mineral examined, there were obtained—

K ₂ O	8.595 p.c.
Li ₂ O	1.754 "
Na ₂ O	0.609 "
Rb ₂ O	0.070 "

A doubtful trace of caesium was recorded as the result of spectroscopic observation, but no thallium was found.

(103.) *Analysis of the so-called "Tobacco Stems" rejected in the Manufacture of Tobacco in Virginia.* By C. G. MEMMINGER, of Charleston, South Carolina.

This material consists of the midribs of tobacco leaves, from which the membranous portions of the leaves have

been stripped. The rejected midribs are in part ground up and used as inferior material in the production of some forms of manufactured tobacco, but much remains as waste, and enquiries have repeatedly been made here within the last few years as to the value to be attributed to such waste if applied as manure to land, or if mixed with other matters in forming manure composts. To answer such questions, the following analysis was made by Mr. Memminger of a fair average sample of commercial "stems," produced in the manufacture of "plug tobacco," and obtained from the firm of S. W. Venable and Co., of Petersburg, Virginia:—

Water lost at 100° C.	17.52
Total ash (excluding CO ₂), sum of constituents ..	16.47
CO ₂ (by calculation from excess of basic over other acid constituents)	6.87
(Ditto, directly determined, 6.73)	
Organic matter (by difference)	59.14
	<hr/> 100.00

In the Organic Matter—

Nicotine (determined by Kissling's method) .. .	1.30
Nitrogen in 1.30 per cent nicotine	0.22
" " nitrates (by mercury process)	0.45
" " albumenoid (by difference)	1.51
Total nitrogen (by Ruffle's method of combustion*)	2.18

Composition of the Ash.

	Including SiO ₂ , Al ₂ O ₃ , Fe ₂ O ₃ , and Mn ₂ O ₄ .	Excluding SiO ₂ , Al ₂ O ₃ , Fe ₂ O ₃ , and Mn ₂ O ₄ .
K ₂ O	42.95	46.25
Na ₂ O	6.53	7.03
CaO	24.56	26.47
MgO	6.20	6.68
Al ₂ O ₃	0.04	—
Fe ₂ O ₃	0.84	—
Mn ₂ O ₄	0.09	—
SiO ₂	6.18	—
P ₂ O ₅	4.80	5.17
SO ₃	3.10	3.30
Cl	6.04	6.56
Deduct O equiv. to Cl	—1.33	—1.46
	<hr/> 100.00	<hr/> 100.00

University of Virginia,
July 27, 1883.

A METHOD FOR THE QUANTITATIVE SEPARATION OF POTASSA AND SODA FROM FERRIC OXIDE, ALUMINA, LIME, AND MAGNESIA IN SILICATES.

By W. KNOP.

If in dissolving a siliceous mineral we employ a mixture of one-third fuming hydrochloric acid and two-thirds hydrofluoric acid, everything dissolves during evaporation to a clear liquid, but on further concentration hydrochloric acid escapes, and the alkaline silico-fluorides reappear along with the chlorides of iron, aluminium, calcium, and magnesium.

If a silicate contains a quantity of silica equal to its proportion of alkaline metals, or if, supposing the silica to be insufficient or totally wanting, we dissolve the substance in 10 to 20 c.c. of water, and a few c.c. of hydrochloric acid and add a corresponding quantity of silica, we can convert its alkali metals completely into silico-fluo-

* *Loc. cit.*

* *Jour. Chem. Soc.*, xxxix., p. 87. CHEMICAL NEWS, vol. xlvii., p. 75.

rides, by adding the requisite quantity of fuming hydrofluoric acid and evaporating.

The alkaline silico-fluorides are absolutely insoluble in a mixture of ether and absolute alcohol strongly acidified with hydrochloric acid. Hence the alkaline silico-fluorides may be precipitated from a hydrochloric solution in the form of a crystalline deposit by the addition of ether and absolute alcohol. But if the hydrochloric solution contains also chlorides of iron, aluminium, calcium, and magnesium, the alkaline silico-fluorides are deposited, not in a pure state, but in combination with small quantities of the above-mentioned metals, the bulk of which, however, remain in solution as chlorides.

The process is carried out as follows:—The weighed substance is mixed in a platinum crucible with a few c.c. of water, and in case of need with a corresponding quantity of silica. A sufficiency of hydrofluoric acid is then added and all the liquid is evaporated away. The dry residue is covered with 2 to 3 c.c. of fuming hydrochloric acid, upon which it is readily detached from the crucible. It is washed into a beaker by means of an alcohol washing-bottle, using 25 or at most 50 c.c. of absolute alcohol for washing out the crucible; the acid liquid is allowed to act for some time upon the precipitate. 100 c.c. of ether are then added, and the whole is allowed to stand for 12 hours.

The ethereal liquid is poured off from the precipitate, and the alkaline silico-fluorides are brought upon a filter by means of an alcohol washing-bottle. The use of a feather is admissible only at the beginning; a glass rod is objectionable because it makes the precipitate adhere again to the inside of the glass. The precipitate may be transferred easily if the beaker is held in a sloping position over the filter, and a few c.c. of alcohol are ejected behind the precipitate so as to wash it into the filter.

The filter is then washed slightly with alcohol, so as to remove the ether; it is then dried, the precipitate removed, the paper is burnt completely in a platinum capsule; the precipitate is added to the ash, mixed with concentrated sulphuric acid, allowed to stand for some time until the silico-fluoric gas has chiefly escaped, and then ignited so long and at so low a temperature that the alkalis may remain behind as acid sulphates and be unable to react upon the silica liberated.

The residue in the capsule is drenched with 10 to 20 c.c. of ammonia and evaporated to dryness, or at least to a paste-like condition. The mass takes again an acid condition by the loss of ammonia, and strong ammonia is therefore added drop by drop until the reaction is again alkaline. The mixture is then allowed to stand for an hour to allow of the complete separation of the ferric oxide and the alumina. Upon the pasty mass is then poured about 20 c.c. of a solution of ammonium monocarbonate (prepared by mixing 180 c.c. ammonia sp. gr. 0.92 with 230 grms. ammonium sesquicarbonate and water enough to make up one litre), and allowed to stand for 12 hours in the covered platinum capsule.

The quantities of ferric oxide, alumina, lime, and magnesia thus separated are so small that the entire precipitate may be collected upon a very small filter. It is washed with the smallest possible quantity of the above-mentioned ammonium carbonate.

The filtrate is now exposed first for some time to a very gentle heat, a quantity of ammonium bitartrate corresponding to the ammonium sulphate present in the solution is added, the liquid is evaporated to dryness, and the residue is heated for some time in the air-bath to a temperature above 100°. The object of adding ammonium bitartrate is to prevent spitting during the ignition of the ammonium sulphate. The residue is ignited till perfectly white, and weighed. It is then re-dissolved in hot water, mixed with 2 to 3 drops of the solution of ammonium monocarbonate and set aside to see if any further deposit of iron oxide and alumina takes place.

If this is the case the liquid is again evaporated to dryness. These supplemental deposits generally attach

themselves so firmly to the platinum that a clear solution is obtained on drenching the residue with 10 to 20 c.c. of boiling water. This solution is decanted into a second platinum capsule in which the solution is evaporated to dryness and the capsule is again strongly ignited and weighed. It is recommended to add a few drops of sulphuric acid during this second evaporation.—*Zeitschrift für Analyt. Chemie.*

ON THE VOLUMETRIC DETERMINATION OF COPPER BY MEANS OF POTASSIC CYANIDE.— PARKES'S PROCESS.*

By J. J. and C. BERINGER.

THE process is based upon the facts (1) that when ammonia is added in excess to a solution containing copper, ammoniacal copper compounds are produced which give to the solution a deep blue colour; and (2) that when potassic cyanide is added in sufficient quantity to such an ammoniacal solution the colour is removed, double cyanides of copper and potassium and ammonium being formed.

Except under certain conditions hereinafter stated, reliance on the accuracy of the process cannot rest upon the supposition that the cyanide required for decolouration is proportional to the copper present; for that this in the ordinary way of working is incorrect is well known. A decomposition of the cyanide goes on, of which urea, oxalate of urea, and formate of ammonia are some of the products.

"The decomposition is not always the same, the quantity and degree of concentration of the ammonia has a marked influence on it," and "neutral ammonia salts also affect the result."† Referring to this effect of ammoniac salts, Crookes, in his description of Steinbeck's modification of the process, states that when "larger quantities of ammoniacal salts are present, . . . and especially when carbonate, sulphate, and, worse still, chloride of ammonium, are simultaneously present, these salts exert a very disturbing influence."‡

Notwithstanding this objection the method is largely used, and yields fairly accurate results when "the standardising of the cyanide of potassium and the actual analysis are performed under very similar circumstances." "The results are not only concordant, but also very nearly correct, if the cyanide is standardised under the same conditions as it is used. In standardising, about the same quantity of copper should be employed as will have to be estimated."||

In our opinion, for accurate work it is best to have the assay solution, and that used for standardising, the same as nearly as possible, even to containing about the same amount of ferric hydrate; and to titrate the two solutions side by side.

It occurred to us that the interference of ammoniac salts is due to a reaction with potassic cyanide, by which ammoniac cyanide is formed; and that the excess of cyanide is required either because ammoniac cyanide decomposes more rapidly, or because it is less active than the corresponding potassium salt. In this case the use of soda or potash for neutralising the excess of acid used for dissolving the ore would eliminate the disturbing element. It seemed to us, too, advisable to determine whether the conditions of the assay might be so arranged as to yield proportional results. With a view of solving these

* From the "Reports and Proceedings of the Miners' Association of Cornwall and Devon."

† Fresenius "Quantitative Analysis," vol. i., page 259

‡ "Select Methods in Chemical Analysis," p. 193.

|| Fresenius.

problems we tried a large number of experiments, in which we used—

Standard "Copper Sulphate."—15.753 grms. of recrystallised copper sulphate, dissolved and diluted to 1 litre.

*Standard "Potassic Cyanide."**—35 grms. of potassic cyanide, dissolved and diluted to 1 litre.

"Ammonia."—One volume of Liq. Ammonia, sp. gr. 88°, diluted to 5 volumes.

"Soda."—A 10 per cent solution of caustic soda.

Effect of Variations in the Manner of Working.

In the experiments, except it is otherwise stated, the bulk of solution at the end of the assay was about 325 c.c.† The "cyanide" was run in rather quickly until the colour became very perceptibly fainter (*i.e.*, to within 1.0 or 1.5 c.c. from the end). It was then run in deliberately, but without protracted delay, five or six drops at a time, then two, then one, until the faintest possible tint of violet remained. A titration thus performed occupies from three to four minutes.

There is no doubt that different modes of working will yield different finishing points. In five experiments, in which the time occupied in titration varied from five minutes to half an hour, the quantities of "cyanide" required were 24.8 c.c., 24.5 c.c., 24.2 c.c., and 24.6 c.c. respectively. Another, titrated in the manner described above, required 24.8 c.c. The quantity used seemed to depend less upon the actual time occupied in the assay than upon the speed with which the last 2 or 3 c.c. were run in. In each experiment "copper sulphate" 50 c.c., "ammonia" 75 c.c., and "soda" 4 c.c. were used. These experiments indicate that everything depends upon the mode of finishing. The following experiments show that the excess of cyanide acts very slowly; we made a series of five solutions, similar to the last:—

1. Titrated in the ordinary way, required 24.8 c.c. of "cyanide."
2. Added 24.6 c.c. of "cyanide." After standing five minutes this had still a blue tint, but was almost finished.
3. Added 24.4 c.c. of "cyanide." Blue tint, nearly done, after standing seven minutes."
4. Added 24.2 c.c. of "cyanide." After five minutes was distinctly blue; after 15 minutes was still blue, but nearly done.
5. Added 24.0 c.c. of "cyanide." Was very distinctly blue after standing half an hour; after an hour and a half was paler, but distinctly blue.

Another series of experiments was made to determine whether or not delay, when an insufficient amount of cyanide had been added, had any marked result. Three solutions like those used above were made, and to 1 was added 20 c.c. of cyanide solution; to 2, 18 c.c.; and to 3, 12 c.c. After standing in stoppered bottles for forty hours each was distinctly blue, and the titration being then completed in the usual manner. 1 required 4.8 c.c.; 2, 6.8 c.c.; and 3, 12.8 c.c. of standard cyanide; making the total "cyanide" required in each case 24.8 c.c. A new solution titrated at the same time required 24.9 c.c.

We think that, taken together, the experiments show that everything depends upon the manner of finishing, and that a fictitious finishing point must of necessity be adopted; and our general experience tells us that such an adoption having been made, there is no difficulty in getting concordant results.

Effects of Variation in Temperature.

We used "copper sulphate," 50 c.c.; water, 150 c.c.; soda, 4 c.c., warmed; then added ammonia, 75 c.c., and

* During the experiments several lots of cyanide solution were made; and these were not all of exactly the same strength. Each series of experiments, however, was made with the same solution.

† The titration was performed in white glass stoppered bottles, holding when full about 340 c.c.

sufficient water to make up the bulk to 300 c.c.; titrated, and took the temperature of the solution.

Temperature.. .. 10° C. 20° C. 35° C. 47° C.
"Cyanide" required 23.5 c.c. 23.3 c.c. 23.05 c.c. 22.85 c.c.

Effect of Ammonia and Ammonic Salts.

In our first experiments we found that 50 c.c. "copper sulphate" and 100 c.c. "ammonia" required 24.2 c.c. of potassic cyanide, whereas the same solution in which part of the ammonia had been converted into ammonic nitrate by the addition of 80 drops of strong nitric acid (sp. gr. 1.42) required 25.5 c.c.; clearly showing that ammonic nitrate interferes much more than its equivalent of ammonia does.

In order to determine whether nitrate, chloride, and sulphate of ammonia agree in their disturbing effect, we made a solution of sesquicarbonate of ammonia (4 grms. of the salt to 100 c.c.), and in three experiments added to the assay 100 c.c. of this, previously neutralised, in one case with sulphuric acid, in the second with nitric acid, and in the third with hydrochloric. In each case 50 c.c. "copper sulphate" and 100 c.c. of ammonia were used. Without ammonia salts 24.2 c.c. of "cyanide" were required, with ammonic chloride 25.7 c.c., with ammonic sulphate 25.7 c.c., and with ammonic nitrate 25.6 c.c. Strangely enough 100 c.c. of the solution of ammonic carbonate had the same effect, *i.e.*, 25.6 c.c. were required. But on repeating the experiments, and adding in each case 3 c.c. soda, this was no longer so. The results (a somewhat weaker cyanide solution was used) were—

Without ammonic salts ..	25.6 c.c. cyanide required.
With ammonic carbonate ..	26.4 " " "
" " sulphate ..	26.7 " " "
" " chloride ..	26.75 " " "
" " nitrate ..	26.75 " " "

From these it is a fair inference that the same quantity of ammonia has the same effect whether it be present as sulphate, nitrate, or chloride.

To show the effect of a gradually increasing quantity of ammonia we used 50 c.c. of "copper sulphate" diluted with water, and ran in "cyanide" until the precipitate first formed was re-dissolved. In the other experiments the same quantity of copper was used, ammonia was added, and the titration completed in the ordinary way.

Ammonia added—

0.0	2.0 c.c.	5.0 c.c.	10.0 c.c.	20.0 c.c.	30.0 c.c.
Cyanide required—					
21.8 c.c.	22.5 c.c.	22.8 c.c.	23.0 c.c.	23.3 c.c.	23.4 c.c.

Ammonia added— 50.0 c.c. 100.0 c.c.

Cyanide required— 23.7 c.c. 24.2 c.c.

A similar series of experiments made to determine the effect of variation in the quantity of ammonic nitrate gave the following results:—

AmNO₃ added—

0.0	1 grm.	2 grms.	4 grms.	12 grms.
Cyanide required—				
24.2 c.c.	24.6 c.c.	25.0 c.c.	25.4 c.c.	26.5 c.c.

In each case copper sulphate 50 c.c. and ammonia 100 c.c. were used.

Effects of Sodid Salts and Soda.

Experiments in which salts of soda and potash were added show that the sulphates, chlorides, and nitrates have little or no action, whilst the hydrates, carbonates, bicarbonates, sulphites, and nitrites have an important effect. It is curious that less cyanide is required in the presence of sodic sulphite.

We used copper sulphate 50 c.c., ammonia 75 c.c., soda 4 c.c. in each case; and added 6 grms., 12 grms., and 24 grms. of the salt whose effect we wished to determine. Without any such addition 24.9 c.c. of "cyanide" were required.

With *sodic sulphate* crystals the quantities of cyanide used were 24.9 c.c., 25.05 c.c., 25.1 c.c.

With *sodic chloride*, 24.95 c.c., 25.00 c.c., 25.1 c.c.

With *sodic nitrate*, 24.9 c.c., 24.9 c.c., 24.95 c.c.

The results thus got indicate the probable advantage of neutralising with soda instead of ammonia; in doing this it is scarcely possible to avoid using a slight excess of soda. It therefore became important to determine the effect of different quantities of this substance; in the experiments 50 c.c. copper sulphate and 75 c.c. ammonia were used.

Soda added—

0.0 1.0 c.c. 5.0 c.c. 10.0 c.c. 20.0 c.c. 50.0 c.c.

Cyanide required—

25.8 c.c. 26.0 c.c. 26.4 c.c. 26.9 c.c. 27.25 c.c. 28.00 c.c.

Conditions under which Proportional Results may be obtained.

Ammonic salts being absent, the temperature and mode of working being always the same, and only a very slight excess of soda being present, the problem is simplified; it only remains to determine the conditions in regard to ammonia and bulk under which the best results may be obtained.

When the copper, ammonia, and bulk vary, but maintain their relative proportions, the quantity of cyanide required is strictly proportional to the copper present.

	Copper Sulphate.	Ammonia.	Bulk.	Cyanide.
1.	10 c.c.	20 c.c.	60 c.c.	4.7 c.c.
2.	20 "	40 "	120 "	9.45 "
3.	40 "	80 "	240 "	18.9 "
4.	50 "	100 "	300 "	23.7 "

If the quantity of copper and the bulk remain constant, and the ammonia be increased, more cyanide is required.

	Copper Sulphate.	Ammonia.	Bulk.	Cyanide.
5.	50 c.c.	50 c.c.	300 c.c.	22.7 c.c.
4.	50 "	100 "	300 "	23.7 "
6.	50 "	200 "	300 "	24.5 "

The quantities of ammonia and copper remaining constant, the bulk increasing, less cyanide is required.

	Copper Sulphate.	Ammonia.	Bulk.	Cyanide.
7.	50 c.c.	100 c.c.	150 c.c.	24.0 c.c.
4.	50 "	100 "	300 "	23.7 "
8.	50 "	100 "	450 "	23.5 "

If, however, the addition of ammonia causes an increase, and an addition of water a decrease, in the quantity of cyanide required, it follows that there must be a solution of ammonia of such strength that the effect of the ammonia is neutralised by that of the water. The addition of such a solution to an assay should not affect the result; and in such a solution the quantity of cyanide required should be proportional to the copper present, so long at least as the latter does not vary within very wide limits.

In following up this last we tried two series of experiments:—1, containing in each assay 25 c.c. copper sulphate and 2 c.c. of soda; in 2, 75 c.c. copper sulphate and 6 c.c. "soda," with different quantities of ammonia. The quantities of cyanide required were as follows:—

"Ammonia"—

25.0 c.c. 40.0 c.c. 50.0 c.c. 75.0 c.c. 100.0 c.c. 150.0 c.c.

Cyanide required—

1. 11.2 " 11.5 " 11.7 " 11.9 " 12.1 " 12.5 "

2. 34.65 " 34.9 " 35.3 " 35.6 " 36.05 " 36.7 "

The results with 75 c.c. of ammonia are very closely what they would be if the cyanide used were proportional to the copper present. Another experiment, using 100 c.c. copper sulphate and 75 c.c. ammonia, required 47.6 c.c. of cyanide, which is exactly the proportional. This agreement is confirmed by the fact that throughout the series the error becomes gradually less, and then again increases

in the opposite direction. Comparing the calculated results for the 2nd series with those found, we have—

Calculated	33.6	34.5	35.1	35.7	36.3	37.5
Found ..	34.65	34.9	35.3	35.6	36.05	36.7
Error ..	1.05	0.4	0.2	-0.1	-0.25	-0.8

We think these show conclusively that there is a certain strength of ammonia with which proportional results may be got, and that titrating in the manner we have described, in a slightly alkaline solution, this strength is 15 c.c. of strong ammonia (88°) to each 300 c.c. of solution.

In conclusion, we have to thank Messrs. Anstey and Hall, students in the Camborne Laboratory, for their care and trouble in performing a large number of the experiments.

ON THE PRECIPITATION OF TITANIC ACID.

By PETER T. AUSTEN and F. A. WILBER.

IN the analysis of titaniferous ores by fusion with the carbonates and nitrates of the alkalies, the fused mass is soaked out with water, the solution acidified with chlorhydric acid, evaporated to dryness to render the silica insoluble, then taken up with chlorhydric acid and water, and filtered. In the residue consisting of silica, containing more or less ferric oxide, titanic acid, and phosphoric acid, the silicic acid is determined by expulsion with fluorhydric acid. The residue consisting of titanic acid, ferric oxide and phosphoric acid is then fused with an alkaline bisulphate, and the resulting solution added to the chlorhydric acid solution, which has been freed from platinum by treatment with hydrogen sulphide.

To determine the titanic acid in this chlorhydric acid solution it is necessary to precipitate an aliquot part of it with an excess of potassium hydrate (first oxidising the ferrous salts by potassium chlorate), filter off and wash the bulky gelatinous precipitate of ferric oxide, titanic acid, phosphates, &c., dissolve the mass in sulphuric acid, reduce and precipitate the titanic acid by boiling. It is not practicable to precipitate the titanic acid directly by boiling the chlorhydric acid solution, since the precipitation by this method is not complete, and when thus precipitated it runs through the filter-paper as soon as the wash-water ceases to be acid. If the wash-water is acidified with chlorhydric acid, the precipitate is more or less dissolved.* The filtration and washing of this precipitate is extremely irksome, and, like that of the basic acetates, is seldom really perfect.

On the other hand the method of decomposing the ores with an alkaline bisulphate, which yields at once a sulphuric acid solution, is often very tedious, on account of the stability of many ores toward this flux and the length of time that it frequently takes to remove the fused mass from the crucible, especially when potassium bisulphate has been used and the temperature has been too high, or not enough sulphuric acid has been added at the close. There are but few ores which are not decomposed by the alkaline carbonates and nitrates when the fusion is finished in a small Fletcher injection furnace, and if rightly handled during cooling the fusion will come out of the crucible in a few hours.

The results obtained by Streit and Franz† do not seem to have been utilised in the analysis of titaniferous iron ores. According to these authors, titanic acid may be precipitated from its chlorhydric acid solution in a form which can be easily filtered and washed, when to the solution one-third of its volume of sulphuric acid (containing one-sixth volume of H₂SO₄) and one-fifth of its volume of acetic acid are added. In using this method, however, we have found that when considerable amounts of chlorhydric acid were present, the addition of so much

* Rose, *Quant. Anal.*, 1871, 2, 313.

† *Journ. pr. Chem.*, 103, 65.

sulphuric acid prevented the precipitation of the titanio acid.

If also it is the intention to determine manganese by the beautiful oxalate method of Classen* which does away with the tedious basic acetate procedure, it is of importance that but a small amount of sulphates should be present.† We were led, therefore, to experiment on the precipitation of titanio acid from its chlorhydric acid solution by the addition of acetic acid alone, and find that it answers the purpose in every way as well, if not better, than when a mixture of acetic and sulphuric acids is employed. The titanio acid is precipitated from its reduced solution on boiling as a flocculent precipitate which settles rapidly and well. The hot solution can be easily filtered without waiting for it to settle. The precipitate shows no tendency to run through the paper if washed with hot water acidified with acetic acid. In fact the addition of a little acetic acid to the wash-water, in cases where the titanio acid, precipitated by the usual method, shows a tendency to run through, stops it at once. The titanio acid when precipitated in the presence of acetic acid, from a chlorhydric solution containing ferrous salts of iron, is as free from iron as when precipitated by the usual method. It is rare that a precipitate of titanio acid is obtained perfectly free from iron in actual analysis when the solution contains a considerable amount of iron. In the presence of phosphates it always contains iron and phosphoric acid,‡ and has to be worked over again.

A number of experiments were made with titaniferous ores to ascertain if the precipitation of titanio acid from a chlorhydric solution in the presence of acetic acid was complete. In no case could the slightest trace of titanio acid be detected in the filtrates by means of tin and chlorhydric acid.

There are, of course, many modifications possible in the analysis of titaniferous ores, and various applications can be made of this method of precipitating titanium, but the following course seems to offer some advantages.

The ore is fused with alkaline carbonates and nitrates, and after taking up with water in the usual manner, is acidified with chlorhydric acid and evaporated to dryness to render the silica insoluble. It is then moistened with chlorhydric acid and treated with a little warm water till solution of the soluble parts has been effected, after which it is allowed to cool, and then diluted, without filtering, to 400–500 c.c. Sulphurous acid is next added, and then 50–60 c.c. of acetic acid. On boiling in the usual manner, the titanio acid will be precipitated in a flocculent and easily filterable state. The whole is then filtered and washed with hot water containing a little acetic acid. If the ore does not contain phosphoric acid this precipitate will be quite free from iron, and after expelling the silica by treatment with ammonium fluoride and sulphuric acid is generally pure enough to be taken as titanio acid, although in certain cases where the amount of titanio acid is small and the amount of iron large, a re-fusion is often necessary. In case the ore contains phosphates, the titanio acid precipitate will always contain iron and phosphoric acid. In this case, the residue, after expelling the silica with ammonium fluoride, can be fused with sodium carbonate and the fusion extracted with water, which dissolves the sodium phosphate and leaves the sodium titanate and ferric oxides.|| This residue is then fused with a little sodium bisulphate, and the titanio acid precipitated after reduction by boiling. The filtrate containing the iron which was precipitated with the silica is now added to the filtrate from the original precipitation of the titanio acid, and the acidified filtrate from the fusion of the titanio acid with sodium carbonate,§ and the united solutions analysed for alumina,

iron, manganese, calcium, and magnesia, after freeing it from platinum by precipitation with hydrogen sulphide. —*Amer. Chem. Journ.*

BEHAVIOUR OF THE ACETATES OF CHROMIUM IRON, AND ALUMINIUM.

By B. REINITZER.

If a solution of chromium sulphate or chloride is mixed with an excess of sodium acetate and boiled no deposit is formed even after hours of ebullition, however concentrated the solution, and however much sodium acetate is added. If the solution is boiled for a short time only it takes on cooling a violet colour.

The solution of a chromic salt thus treated is found to have assumed decidedly new properties. Caustic alkalies, ammonia, ammonium sulphide and carbonate, alkaline carbonates, sodium phosphate, baryta-water and barium carbonate produce in the cold not the slightest turbidity, whether added in small quantities or in excess. Caustic alkalies and baryta change the colour of the solution, at first to an olive-green, and then to an emerald-green, and after standing for twelve hours the liquid congeals to a green jelly. On adding ammonia no immediate change of colour occurs; after about 48 hours the liquid is converted to a violet jelly. Ammonium sulphide and carbonate act in the same manner after the lapse of several days. If the mixture is boiled after the addition of the above-mentioned reagents there appears, according to the strength of the alkaline reaction and the quantity added, sooner or later a precipitate; sodium phosphate alone occasions no deposit.

If the solution contains along with chromic oxide, ferric oxide, and alumina, the chromium acetate imparts its passivity to certain quantities of the ferric and aluminium acetates. Neither by ebullition nor by the addition of caustic alkalies, ammonia, &c., can certain quantities of ferric and aluminium acetate be detected in presence of chromic acetate. Ammonium sulphide makes an exception as far as iron is concerned, since it effects a slow but complete precipitation of iron sulphide. A given quantity of chromium can preserve a given quantity of iron and alumina from precipitation, but larger quantities only if the solution of chromium has been boiled with the sodium acetate before the addition of the solution of iron and aluminium.

If the chromic solution is merely mixed with sodium acetate in the cold the chromium can at first be precipitated in the cold by the above-named reagents. On standing for a day the liquid acquires the same passivity as it would have done on boiling.

From the above it appears that the method of separating ferric and aluminium salts in the form of basic acetates entirely loses its applicability in presence of chromic salts. —*Zeitschrift für Analyt. Chemie.*

Application of Solution of Borax for Extracting Colouring-Matters.—R. Palm.—For isolating alizarin and purpurin from garancine the author digests in a solution of borax saturated in the cold until a deep blood-red solution is formed. The liquid is filtered and completely precipitated with sulphuric, hydrochloric, or acetic acid. The bulky violet-brown precipitate is boiled for a long time with a saturated solution of alum. From the filtered decoction alizarin is deposited on cooling and filtered off. The filtrate deposits alizarin on the addition of concentrated sulphuric acid. The author also applies borax for the extraction of santaline from sanders wood, and a violet colouring-matter, not identical with carmine, from cochineal. —*Zeitschrift für Anal. Chemie.*

* *Fres. Zeit.* 18, 175.

† *Fres. Zeit.* 18, 187.

‡ Bogardus, *Am. Journ. Sci.*, 3, 8, 334.

|| Drown and Shimer, *Am. Journ. Sci.*, 4, 6.

§ This is hardly necessary unless phosphoric acid is to be determined in this solution

A RECALCULATION
OF
THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.
Chief Chemist to the U.S. Geological Survey, Washington.

BARIUM.

For determining the atomic weight of barium we have a series of six ratios, established by the labours of Berzelius, Turner, Struve, Pelouze, Marignac, and Dumas. Andrews† and Salvétat,‡ in their papers upon this subject, gave no details nor weighings; and, therefore, their work may be properly disregarded. First in order in point of importance, if not first chronologically, is the ratio between silver and anhydrous barium chloride, as determined by Pelouze, Marignac, and Dumas.

Pelouze,|| in 1845, made the three subjoined estimations of this ratio, using his well known volumetric method. A quantity of pure silver was dissolved in nitric acid, and the amount of barium chloride needed to precipitate it was accurately ascertained. In the last column I give the quantity of barium chloride proportional to 100 parts of silver:—

3.860 grms. BaCl ₂ ppt.	4.002 grms. Ag	96.452
5.790 "	6.003 "	96.452
2.895 "	3.001 "	96.468

Mean 96.4573 ± 0.0036

Essentially the same method was adopted by Marignac§ in 1848. His experiments were made upon four samples of barium chloride as follows. A, commercial barium chloride, purified by re-crystallisation from water. B, the same salt, calcined, re-dissolved in water, the solution saturated with carbonic acid, filtered, and allowed to crystallise. C, the preceding salt, washed with alcohol, and again re-crystallised. D, the same, again washed with alcohol. For 100 parts of silver the following quantities of chloride were required:—

A.
96.356
96.345
96.362

Mean 96.3543 ± 0.0033

B.
96.356
96.452

Mean 96.354 ± 0.0013

C.
96.358
96.363

Mean 96.3605 ± 0.0017

D.
96.346
96.384
96.361
96.377

Mean 96.367 ± 0.0057

Dumas¶ employed barium chloride prepared from pure barium nitrate, and took the extra precaution of fusing the salt at a red heat in a current of dry hydrochloric acid gas.

* Smithsonian Miscellaneous Collections. "The Constants of Nature."

† Chemical Gazette, October, 1852.

‡ Comptes Rendus, 17, 318.

§ Comptes Rendus, 20, 1047. Journ. f. Prakt. Chem., 35, 73.

¶ Arch. d. Sci. Phys. et. Nat., 8, 271.

Ann. Chem. Pharm., 113, 22, 1860. Ann. Chim. Phys. (3), 55, 129

Three series of experiments upon three samples of chloride gave the following results:—

Series A.

1.7585 grms. BaCl ₂	= 1.826 grms. Ag.	Ratio 96.303
3.842 "	3.988 "	96.339
2.1585 "	2.2405 "	96.340
4.0162 "	4.168 "	96.358

Mean 96.3325 ± 0.0068

Series B.

1.6625 grms. BaCl ₂	= 1.727 grms. Ag	Ratio 96.265
2.4987 "	2.5946 "	96.304
3.4468 "	3.579 "	96.306
4.0822 "	4.2395 "	96.290
4.2062 "	4.3683 "	96.289
4.4564 "	4.629 "	96.271
8.6975 "	9.031 "	96.307

Mean 96.2902
± 0.0043

Series C.

2.2957 grms. BaCl ₂	= 2.3835 grms. Ag	Ratio 96.316
4.1372 "	4.293 "	96.371
4.2662 "	4.430 "	96.303
4.4764 "	4.647 "	96.329
5.6397 "	5.852 "	96.372

Mean 96.3382
± 0.0096

We have now eight series of experiments upon this ratio, representing thirty distinct estimations. Combining, we get a general mean as follows:—

Pelouze	.. .. .	96.4573	± 0.0036
Marignac, A	.. .. .	96.3543	0.0033
" B	.. .. .	96.3540	0.0013
" C	.. .. .	96.3605	0.0017
" D	.. .. .	96.3670	0.0057
Dumas, A	.. .. .	96.3325	0.0068
" B	.. .. .	96.2902	0.0043
" C	.. .. .	96.3382	0.0096

General mean 96.3596 0.0009

The ratio between silver and crystallised barium chloride has also been fixed by Marignac.* The usual method was employed, and two series of experiments were made, in the second of which the water of crystallisation was determined previous to the estimation. Five grammes of chloride was taken in each determination. The following quantities of BaCl₂.2H₂O correspond to 100 parts of silver:—

A.	B.
113.109	113.135
113.135	113.122
113.097	113.060

Mean 113.114 ± 0.0074 Mean 113.106 ± 0.0154

The general mean from both series is 113.113 ± 0.0067.

The direct ratio between the chlorides of silver and barium was early established both by Berzelius† and Turner.‡ Berzelius found that 100 parts of dry barium chloride gave of silver chloride:—

138.06
138.08

Mean 138.07 ± 0.007

Turner made five experiments, with the following results:—

* Journ. f. Prakt. Chem., 74, 212. 1858.

† Pogg. Anal., 8, 177.

‡ Phil. Trans., 1829, 291.

137'45
137'54
137'70
137'62
137'64

Of these, Turner regards the fourth and fifth as the most exact. These give a mean of $137'63 \pm 0'007$, while the other three are in mean $137'563 \pm 0'049$. Combining Berzelius's figures with those of Turner, we get as follows:—

Berzelius	138'07	$\pm 0'007$
Turner, 1, 2, 3	137'563	0'049
„ 4, 5	137'63	0'007

General mean $137'841 \pm 0'0047$

Incidentally to some of his other work, Marignac* determined the percentage of water in crystallised barium chloride. Two sets of three experiments each were made, the first upon five grammes and the second upon ten grammes of salt. The following are the percentages obtained:—

A.	B.
14'790	14'80
14'796	14'81
14'800	14'80

Mean $14'795 \pm 0'0019$ Mean $14'803 \pm 0'002$

General mean of both series.. $14'799 \pm 0'0014$.

The ratio between barium nitrate and barium sulphate has been determined only by Turner.† According to his experiments 100 parts of sulphate correspond to the following quantities of nitrate:—

112'060
111'990
112'035

Mean $112'028 \pm 0'014$

For the similar ratio between the sulphate and the chloride there are experiments by Turner, Berzelius, Struve, and Marignac. Turner‡ found that 100 parts of chloride ignited with sulphuric acid gave 112'19 parts of sulphate. By the common method of precipitation and filtration a lower figure was obtained, because of the slight solubility of the sulphate. This point bears directly upon many other atomic weight determinations.

Berzelius,|| treating barium chloride with sulphuric acid, obtained the following results in BaSO_4 for 100 parts of BaCl_2 :—

112'17
112'18

Mean $112'175 \pm 0'034$

Struve,§ in two experiments, found—

112'0912
112'0964

Mean $112'0938 \pm 0'0018$

Marignac's¶ three results are as follows:—

8'520 grms. BaCl_2 gave	9'543 BaSO_4 .	Ratio	112'067
8'519 „	9'544 „		112'032
8'520 „	9'542 „		111'995

Mean $112'011 \pm 0'0071$

Rejecting Turner's single result as unimportant, we may combine the other series:—

Berzelius	112'175	$\pm 0'0034$
Struve	112'0938	0'0018
Marignac	112'011	0'0071

General mean .. $112'106 \pm 0'0015$

The data from which we are to calculate the atomic weight of barium may now be tabulated as follows:—

- (1.) $\text{Ag}_2 : \text{BaCl}_2 :: 100 : 96'3596 \pm 0'0009$
- (2.) $\text{Ag}_2 : \text{BaCl}_2.2\text{H}_2\text{O} :: 100 : 113'113 \pm 0'0067$
- (3.) $\text{BaCl}_2 : 2\text{AgCl} :: 100 : 137'841 \pm 0'0047$
- (4.) Per cent of H_2O in $\text{BaCl}_2.2\text{H}_2\text{O}$, $14'799 \pm 0'0014$
- (5.) $\text{BaSO}_4 : \text{BaN}_2\text{O}_6 :: 112'028 \pm 0'014$
- (6.) $\text{BaCl}_2 : \text{BaSO}_4 :: 100 : 112'106 \pm 0'0015$.

From these ratios, with the aid of the atomic weights already established, we can immediately calculate four independent values for the molecular weight of BaCl_2 :—

From (1)	$\text{BaCl}_2 = 207'510 \pm 0'019$
From (2)	„ $207'662 \pm 0'027$
From (3)	„ $207'536 \pm 0'017$
From (4)	„ $206'837 \pm 0'045$

General mean .. „ $207'505 \pm 0'011$

We have here an interesting example of the compensation of constant errors. Ratios (2) and (4) both represent work done by Marignac upon barium chloride containing water of crystallisation. If now, as is not improbable, the salt contained a trifling excess of water, the molecular weight of barium chloride as calculated from (2) would come out too high, while on the other hand the result from ratio (4) would err in the opposite direction. In point of fact, the two results in the present calculation nearly compensate each other, and, on account of their relatively high probable errors, they exert but an unimportant influence upon the general mean.

In conclusion, we have three independent values for the atomic weight of barium:—

From mol. wt. of BaCl_2	$\text{Ba} = 136'765 \pm 0'031$
From ratio (5)	„ $136'795 \pm 0'364$
From ratio (6)	„ $136'595 \pm 0'309$

General mean .. „ $136'763 \pm 0'031$

If $\text{O} = 16$, then $\text{Ba} = 137'007$. In other words, the ratio between oxygen and barium is almost an exact ratio between two whole numbers.

In the above discussion it will at once be noticed that the second and third values for Ba have very high probable errors, and that they therefore exert almost no influence upon the general mean. This fact by no means renders them worthless, however, for at the lowest estimate they are useful in confirmation of the better determinations. It is also highly probable that the method of discussion, rigidly carried out, does not do them absolute justice.

Bone-Black Superphosphate.—Prof. Fr. Farsky.—The author's conclusions are that superphosphate goes back in the soil the more rapidly, the more calcium carbonate is present. The more water circulates in the soil the less is the reversion. Superphosphate of a coarse texture is less liable to reversion than that of a fine grain. As most seeds complete their germination in the soil in seven to fourteen days, it appears that in lime soils plants obtain the phosphoric acid of their nourishment chiefly, if not entirely, from the calcium phosphate soluble in ammonium citrate. In an experimental field fine-grained superphosphate gave a less advantageous result than coarser qualities. Kladno phosphate gave in three cases a better result than superphosphate, except with potatoes. Precipitated phosphate did not act as well as the other phosphates.—*Biedermann's Centralblatt.*

* *Four. f. Prakt. Chem.*, 74, 212. 1858.

† *Phil. Trans.*, 1833, 538.

‡ *Phil. Trans.*, 1829, 291.

|| *Pogg. Annal.*, 8, 177.

§ *Ann. Chem. Pharm.*, 80, 204. 1851.

¶ *Journ. f. Prakt. Chem.*, 74, 212. 1858.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvi., No. 7, August 13, 1883.

On β -Butyl-glycol.—A. Wurtz.—The author compares the β -butyl-glycol of Kekulé obtained as an accessory product of the hydrogenisation of aldehyd with the compound formed on submitting a dilute solution of pure aldol to the action of sodium amalgam, and establishes their identity. He also gives an account of the acetine of butyl-glycol, and of butylene di-iodide.

The Critical Point of Oxygen.—E. Sarrau.—The author has determined by calculation the critical pressure and temperature of this gas, and obtains values closely approximating to those which M. Wroblewski has found experimentally.

Combination-heat of Oxygen and Carbon.—A. Boillot.—The author considers that the essential principle in thermo-chemical determinations relates to the quantity of heat proper to each of the components entering into combination or separating from each other in case of decomposition. Hitherto the heats measured have been only the sums or the differences given by the elements constituting the compounds. For the present the author deals with this problem merely as it regards carbon monoxide and dioxide.

Composition of the Asphalt or Bitumen of Judea.—B. Delachanal.—This bitumen contains 3.14 per cent of sulphur, which cannot be, for the greatest part at least, present in the state of metallic sulphides, since the quantity of ash left on incineration did not exceed 0.273 per cent. On distillation, the bitumen yields oils having a close analogy with those obtained by the distillation of crude petroleum. Some paraffin was also produced.

On Flours.—M. Balland.—From one and the same flour variable quantities of gluten may be obtained according to the manner of operating. The variation depends especially on the degree of hydration of the gluten, and on the washing which it undergoes. To avoid errors the following procedure is recommended. Make a paste with 50 grms. flour and 20 to 25 grms. water, let it lie for twenty-five minutes, and divide it into two equal portions; extract the gluten from the one immediately, and that from the other an hour afterwards; weigh the gluten after having pressed it strongly by hand until the water runs out clear; then wash again for five minutes, and weigh afresh. The mean of the four operations is then taken.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome x., July, 1883.

This number does not contain any chemical matter.

Bulletin de la Société Chimique de Paris.
No. 3, August 5, 1883.

Certain Reactions of Tellurium.—Eug. Demarçay.—The tellurides are generally described as having a reddish violet colour in solution. It seems, however, that the pure tellurides are slightly yellowish, the violet colour being due either to poly-tellurides, or to a tellurium sub-oxide. If we boil the strongly alkaline solution of a telluride with a reducing agent, such as phosphorus or a hypophosphite, the violet colour disappears, giving place to a very faint yellow. If the air is allowed to enter, the colour reappears. This experiment may be modified by replacing the violet solution by the strongly alkaline solution of a tellurite. There is then produced at first an

intense violet solution, which disappears afterwards, but is restored on admitting the air. If the solution is not very alkaline a portion of the tellurium appears to be eliminated as hydro-telluric acid. It seems, then, that the violet compound precedes the formation of the telluride, and is due to some sub-oxide. Mr. Divers, who has recently prepared a sub-oxide, declares it insoluble in alkaline liquids. Perhaps this is a not the case when it is formed in a finely-divided state. Wöhler prepared certain methylated and ethylated tellurium compounds by setting out, from the methyl and ethyl tellurides, bodies not readily obtained. They may be produced more readily by treating powdered tellurium for forty-eight hours with methyl-iodide at 80°.

A Product of the Oxidation of Di-ethyl-benzine.—MM. Allen and Underwood.—This paper is apparently taken from some English journal.

Note on Gladding's Method of Determining Reverted Phosphates.—M. Millot.—From the *Moniteur Scientifique*. Mr. Gladding's process gives results capable of comparison with those of the method commonly employed in France, which consists in treating 1 grm. of super-phosphate with 40 to 50 c.c. of ammonium citrate, saturated and strongly ammoniacal, and allowing them to react for twelve to fifteen hours.

Bibasic Sodium Glycolate.—M. de Forcrand.—The author determines the thermic conditions under which this salt is formed.

Methylation of Phenols.—Camille Vincent.—The liquid methyl chloride now met with in commerce serves for the methylation of phenols in a simple and rapid manner. The phenol to be operated upon is combined with potassa or soda, the product is dried, and treated at a suitable temperature with gaseous methyl chloride. The methylated phenol formed distils over if the temperature is sufficiently high.

The Pyrometer of Boulier Bros.—Ch. Lauth.—The apparatus of MM. Boulier is based upon a very simple principle; the thermometric observation of the temperature assumed by a rapid current of water circulating in the medium (furnace, &c.) which is under observation. The pyrometer is composed of three distinct parts: the explorer, the reservoir, and the interruptor. The explorer is the most interesting part of the apparatus. It is a small cylinder formed of very thin copper a few centimetres in length; one of its extremities is closed, and the other ends in two tubes, one of which is connected with a reservoir of water, while the other is in contact with a thermometer. These two tubes are inclosed in a metal cylinder, which serves as a refrigerator, and which is fed by the reservoir of water. This cylinder is 1 metre in length and 3 centimetres in diameter. The reservoir needs no special description; it is fitted with a ball-cock in order to maintain the water at a constant level. The interruptor is composed of a small balance, which is in equilibrium as long as the current of water acts regularly, but on the least interruption in the circulation of the water it sets in action an electric alarm, and by means of an electro-magnet even cuts off the supply of water. In order to make use of this pyrometer the explorer is placed in communication with the reservoir of water by means of a flexible tube, and after having ascertained that the circulation is regular the explorer is placed in the furnace or muffle, the temperature of which has to be observed; it is fixed firmly in the door or some other part of the furnace, and a few moments afterwards the observations are begun. The water coming from the reservoir circulates in the apparatus; it is heated by contact with the flames or the hot air, which it meets and shows by the thermometer the changes of temperature which it undergoes.

Researches on Mesitylene.—G. Robinet and Albert Colson.—The authors prove that mesitylene dichloride and dibromide are identical with the dihydrochloric and

dihydrobromic ethers of mesitylenic glycol, a body as yet unknown.

Biedermann's Central-Blatt für Agrikultur-Chemie,
Vol. xii., Part 7.

Experiments with Potash Manures.—Prof. Fr. Farsky.—Pure potash salts applied along with bone-dust reduced the crops in all the experiments. The chloride had a less injurious action than the sulphate. The after effects in the second year were favourable with barley and buck-wheat. The Stassfurt manures were tried upon rye, oats, barley, hemp, clover, carrots, &c., with the following results: With barley, and partially with rye and clover, the action was unfavourable. An autumn dressing was found preferable to one in the spring.

Action of Rain, Dew, and Watering upon Plants.—Prof. Julius Wiessner.—The application of moisture to the leaves promotes transpiration and accelerates the movement of the sap. This process may be injurious if the soil does not contain sufficient moisture.

Experiments on the Influence of the Quantity of Seed and the Use of Artificial Manures upon the Yield and the Composition of Oats.—O. Beseler and Prof. M. Maercker.—A sowing of 22 lbs. oats per acre, notwithstanding abundant manuring, does not give so heavy a crop as a sowing of 38 lbs. By a rational manuring the supply of proteine in the harvest can be almost doubled. Of the nitrogen applied in these experiments about 55 per cent was recovered in the harvest.

Injurious Action of Ammonium Sulphocyanide.—Prof. M. Maercker.—An addition of 1 per cent of this compound to superphosphate is harmless. One hundred kilos. per hectare had no injurious action upon oats.

Action of Brine upon Trichinæ.—M. Collin.—The trichinæ in the superficial parts of hams, &c., survived for fifteen days in brine. In a heavy ham the parasites were not entirely destroyed without exposure to brine for two months.

Cosmos les Mondes.

No. 14, August 4, 1883.

A Reclamation of Priority.—Dr. D. Tommasi.—With reference to a memoir by M. F. Brame, which appears in No. 22 of the *Revue Scientifique*, the author points out that he has shown at earlier dates, in several communications presented to the Academy of Sciences, that the quantity of calories transmissible in the circuit in the form of electric energy—or, more exactly, of chemical energy, varies according to the nature of the positive electrode of the battery.

Zeitschrift für Analytische Chemie.

Vol. xxii., Part 3, 1883.

Testing Petroleum.—F. Beilstein.—This paper requires the two accompanying illustrations.

Certain Reactions of Ozone.—A. Wagner.—1. With Anthracene.—The author, considering that anthracene is oxidised to anthraquinone by hydrogen peroxide, tried to obtain the same result with ozone. Some filter-paper was steeped in a boiling solution of anthracene in ether, allowed to evaporate, and the paper, moistened with water, was then suspended for twenty hours in a bottle containing phosphorus partially covered with water. The paper was boiled up with soda-lye and zinc powder, and the boiling solution was quickly filtered. The filtrate had a strong red colouration from the formation of anthranol, and gave with hydrochloric acid a yellowish white precipitate,—a proof that anthraquinone had been formed.

2. With Aniline Hydrochlorate.—If filter-paper recently saturated with aniline hydrochlorate is suspended in a bottle containing air strongly ozonised by means of phosphorus, it soon takes a pure brown colour without a

reddish tone. If strong electric sparks are caused to strike through atmospheric air in presence of such paper, it became a reddish brown, and on subsequent exposure to the air it assumed a decided red. The same experiment succeeded, though more slowly, with pure oxygen in place of atmospheric air.

3. With Diphenylamine.—Paper saturated with an alcoholic solution of diphenylamine, on exposure to air ozonised with phosphorus, took a pale brown colour, without previously assuming a lemon-yellow tint. If similar paper is exposed to air, or oxygen ozonised by electric sparks, a lemon or orange colour is produced which does not turn to a brown on prolonged action.

4. On Sulpho-diphenylamic Acid.—If a few drops of this acid dissolved in concentrated sulphuric acid are poured into a glass filled with air or with pure oxygen, and if electric sparks are allowed to strike through the air in the glass the acid is quickly turned to an intense blue colour. The same acid, on exposure to air ozonised by means of phosphorus, only took a greenish blue on the sides of the capsule.

Chemical Character of the Violet Colour in Ergot, and its Detection in Flour.—R. Palm.—The author shows that the colouring-matter in ergot is not, as commonly supposed, combined with alkaline earths, and describes its behaviour with solvents and reagents. For its detection in meal, the sample, previously dried, is extracted at 30° to 40° with 10 to 15 parts alcohol at 35° to 40° Tralles with the addition of a few drops of ammonia. The mass is then carefully pressed out, the liquid thoroughly precipitated with basic lead acetate, the precipitate is collected on a filter, pressed between folds of bibulous paper, and the residue, whilst still moist, digested with a saturated solution of borax at a very gentle heat. The solution, if ergot was present, takes a characteristic violet colour. For detecting ergot in bread the sample is dried and powdered, and heated gently for five to ten minutes with 10 to 15 parts of alcohol at 40° Tralles. The liquid is filtered through animal charcoal, the filtrate evaporated almost to dryness on the water-bath, and the residue, still moist, is extracted with alcohol at 40°. The solution is again filtered over animal charcoal, and perfectly precipitated with basic or neutral lead acetate.

Detection of Asparagine and Glutamine in the Juices and Extracts of Plants.—E. Schulze.—The author bases a process for the detection of these amides on their precipitation by mercuric nitrate. The juices or extracts to be tested are treated first with lead acetate as long as a precipitate is formed, and to the filtrate is added a solution—not too acid—of mercuric nitrate. The precipitate thus obtained is filtered and washed, and decomposed by sulphuretted hydrogen. The filtrate from the mercury sulphide is then further examined. If it contains either of the above amides it evolves ammonia if heated with potassa or baryta-water.

Determination of Ammonia in Vegetable Juices and Extracts.—E. Bosshard.—This paper requires the accompanying illustration.

Alcohol in the Brain in Cases of Drunkenness.—Dr. H. F. Kuijper.—The author describes the procedure by which he established that two persons found drowned must have been in a state of alcoholic intoxication when they fell into the water.

Replacement of Hydrogen Sulphide by Ammonium Hyposulphite in Systematic Qualitative Analysis.—Anton Orłowski.—This memoir will be inserted in full.

New Method for the Determination of Nitrogen in Organic Bodies.—J. Kjeldahl.—See page 101.

Volumetric Determination of the Fatty Matter in Milk.—Prof. Leo Liebermann.—This paper will be inserted at length.

Determining the Value of Commercial Potassium Iodide.—W. Lenz.—The author has tested the method of Carles (titration with mercuric chloride), and finds it

useless, the result fluctuating by 0.2 to 0.57 per cent with the difference of a single degree in temperature.

Purification of Sulphuretted Hydrogen for Chemical-Legal Investigations.—W. Lenz.—This paper will be inserted at length.

Distillatory Apparatus for Determinations of Alcohol.—Dr. B. Landmann.

Water-Bath with Constant Level.—C. Klement.—These two papers cannot be usefully abridged without the accompanying illustrations.

An Indicator which shows directly the Neutral Concluding-point in Alkalimetry and Acidimetry.—A. Gawalovski.—If alcoholic solutions of phenol-phthaleine and dimethyl-aniline orange (so-called methyl-orange) are mixed together we obtain an indicator which is turned a deep red by a drop of normal alkali in excess, and to a rose colour by a drop of normal acid in excess. If the neutral point is exactly reached the liquid containing this indicator appears of a light lemon-yellow. The changes of colour occur in four to five seconds. The mixture of the two colouring-matters retains its sensibility for at least five days.

Presence of Arsenic in Glass as a Source of Error in the Detection of Arsenic.—W. Fresenius.—Already noticed.

Apparatus and Methods for Gas Analysis.—The improvements of Geppert, Sokoloff, Pszczolka, and Lunge cannot be intelligibly described without the accompanying illustrations; those of E. W. Morley and A. H. Elliot are taken from the CHEMICAL NEWS.

Determination of Hydrogen Phosphide in Gaseous Mixtures.—J. Riban.—Hydrogen phosphide is readily and completely absorbed by a hydrochlorous solution of cuprous chloride.

Heating Apparatus for Laboratory Uses.—J. A. Kaiser.—The author has devised an ignition-furnace, resembling in many respects that of Perrot; a special furnace for heating substances in closed iron tubes at high pressure, and a stove for drying and evaporation.

Quantitative Separation of Potassium and Sodium from Ferric Oxide, Alumina, Lime, and Magnesia in Silicates.—W. Knop.—(See page 110.)

Test for the Purity of Magnesium Pyrophosphate.—B. Tollens.—If the precipitate after ignition is covered for some hours with silver nitrate in the cold, and then heated, it turns yellow if basic magnesium or calcium phosphate, or both these salts, or the citrates of these bases, should be present.

Precipitation of Alumina.—A. Guyard.—If alumina is precipitated in presence of glycerin it falls in dense flocks which are easily washed.

Behaviour of Chromic, Ferric, and Aluminium acetates.—B. Reinitzer.—(See page 114.)

Volumetric Determination of Ferrous Oxide in Hydrochloric Solution by Means of Permanganate.—N. W. Thomas.—The disturbing effect of hydrochloric acid can be obviated if the solution to be titrated is mixed with an aqueous solution of lead chloride.

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T. G. BONNEY, Secretary.

THE LONDON HOSPITAL and MEDICAL

COLLEGE, MILE END, E.—The SESSION 1883-4 will commence on Monday, October 1st, 1883. The Prizes for the past Session, and the Nursing Probationers' Prizes, will be distributed on Tuesday, October 9th, at 8 p.m., by Professor Huxley, P.R.S., who will also make an Address, after which there will be a Conversation, to which all past and present students are invited. FOUR ENTRANCE SCHOLARSHIPS, value £60, £40, £30, and £20, will be offered for competition at the end of September to new Students. Fees for Lectures and Hospital Practice, 90 guineas in one payment, or 100 guineas in three instalments. All resident and other Hospital appointments are free. The resident appointments consist of Five House Physicians, Five House Surgeons, and One Accoucheurship; Two Dressers and Two Maternity Pupils also reside in the Hospital. Special entries may be made for Medical and Surgical Practice. The London Hospital is now in direct communication by rail and tram with all parts of the metropolis.

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OWENS COLLEGE, VICTORIA UNIVERSITY, MANCHESTER.

SESSION 1883-84.

I. DEPARTMENT OF ARTS AND LAW.

II. DEPARTMENT OF SCIENCE AND ENGINEERING.

Candidates for admission in these Departments must not be under 14 years of age, and those under 16 will be required to pass an Entrance Examination in English, Arithmetic, and Elementary Latin, to be held on the 28th September.

III. DEPARTMENT OF MEDICINE AND SURGERY.

Students are required before entering to have passed one of the Preliminary Examinations prescribed by the General Medical Council.

The SESSION in DEPARTMENTS I., II., and III., will COMMENCE on the 2ND OCTOBER.

IV. DEPARTMENT FOR WOMEN (223, Brunswick Street).

The Session will commence on the 8th October.

V. EVENING CLASSES.

The Session will commence on the 15th October. New Students will be admitted on the 10th, 11th, and 12th October, between 6.30 and 9 p.m.

ENTRANCE EXHIBITIONS are offered for competition at the beginning of the Session in *Classics, Greek Testament, Mathematics, English and History*, and also a *Dauntsey Medical Scholarship*, value £100.

Prospectuses of the several Departments may be obtained at Mr. CORNISH'S, Piccadilly, Manchester; and they will be forwarded from the College, on application.

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THE CHEMICAL NEWS

AND

JOURNAL OF PHYSICAL SCIENCE.

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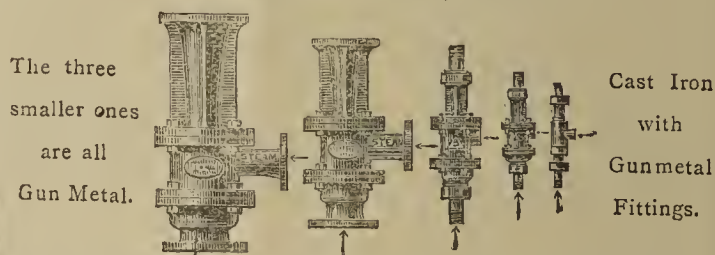
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WOODCOCK and SONS, Secretaries.

West View, Haslingden,
29th August, 1883.

THE CHEMICAL NEWS.

VOL. XLVIII. No. 1242.

ADDRESS TO STUDENTS.

It has been our custom at this time of the year to throw out a few hints in the hope that they might be of some use to persons beginning or continuing the study of chemistry. We have repeatedly insisted upon the necessity of thoroughness, of a thing-knowledge of the science, as distinguished from a mere word- or book-knowledge. We have advised the student to acquire facts and principles by actual work in the laboratory, using book mainly for the purpose of collating and arranging the results of experiment and observation. At the same time we have not failed to recognise the difficulty of combining such thorough thing-knowledge with that power of answering questions which the examinational system, unhappily dominant in England, as in China, requires. We have admitted that the man who knows and does not pass is a misfortune to himself and his teachers, whilst he who passes and does not know, —the more common case,—is a discredit to Science and to mankind. But we have not been able to write out any neat and simple formula for combining these two ends, and securing success to the meritorious, or merit to the successful. We must therefore leave this subject to the judgment and the conscientiousness of each teacher, and to the honest endeavour of each student.

At other times we have asked young men commencing the study of chemistry to reflect well what are their motives for so doing? We have cautioned them that though a knowledge of the science is of great practical advantage in many callings, yet that it does not under ordinary circumstances form the basis of a distinct and independent profession. The emoluments, even of a very able analytical chemist, may fall below those of a bricklayer, whilst he is denied the privilege, open to every other profession under the sun, of sometimes blundering.

For the present, then, we wish to plead the cause of pure chemistry, and to call attention to the departments where more work is urgently required. True, such work is in great part beyond the reach of the student. But he may at least seek to qualify himself for it, and keep it in view as an ultimate object.

We boast in these days of our organic syntheses. We are able to make in the laboratory, and even in the workshop, not a few compounds which a century ago were obtained by the intervention of animal or vegetable life. But if we ask what are our raw materials, our starting-points, we must own that the scientific meaning of these results is much abated. In very few cases can we take the elements as they occur in the free state, or in purely inorganic bodies, and unite them into organic compounds. Our vaunted alizarin, artificial indigo, vanillin, and the like, are formed merely from the residues of living beings. To increase the small number of organic compounds which can be truly formed from inorganic matter would be a most worthy life-task. Whether or not it might prove commercially remu-

nerative is, of course, from our present point of view, totally beside the question. Not till we can really produce all chemical individuals—as distinct from physiological organisms—from purely inorganic matter, can we truly venture to say that the chemical boundary between the organic and the inorganic is cancelled.

Or the student may look in a different direction. In chemistry, as well as in other sciences which we are not called upon to discuss, we find a vast and, we fear, an increasing mass of assumptions, which, if capable of demonstration, are certainly as yet unproven, of terms to which no definite meaning is attached, and even of facts, or what pass for such, sadly in need of verification. Here, then, is work remaining to be done which in quantity is all but infinite, and in importance is second to none. It is surely to be deplored that the philosophy of chemistry is so much neglected. It would be, indeed, idle to overlook the importance of the contributions in that direction which have been furnished by Mendelejeff, by Lothar Meyer, Newlands, and others. But the great mass of chemists fancy that if they have formed and analysed some dozen compounds hitherto non-existent and assigned them "paper constitutions," they have fulfilled all righteousness. Surely so long as we have no reason to suppose ourselves acquainted with all the simple bodies existing in our earth, so long as the claims of not a few substances to the elementary rank are doubtful, whilst the questions of Prout's law, of the foundations of thermochemistry, and even of the indecomposability of the reputed elements, are undecided, we may boldly assert that the routine work of the majority of laboratories, however useful and valuable, is not all, nor even the highest that may be fairly demanded. We must look to our students for a chemistry of the future, which shall arrive at the greatest results by not professing to be wise beyond what is demonstrated.

UNIVERSITIES AND COLLEGES.

UNIVERSITY OF LONDON.

CANDIDATES for any Degree granted by this University are required to have passed the Matriculation Examination, to which no candidate is admitted unless he has produced a certificate showing that he has completed his sixteenth year.

The Fee for this examination is £2.

The Examination will be held on Monday, January 14th, 1884. It is conducted by means of Printed Papers; but the Examiners are not precluded from putting, for the purpose of ascertaining the competence of the Candidates to pass, *viva voce* questions to any Candidate in the subjects in which they are appointed to examine.

Candidates are not approved by the Examiners unless they have shown a competent knowledge in each of the following subjects:—Latin. Any two of the following Languages:—Greek, French, German, and either Sanskrit or Arabic. The English Language, English History, and Modern Geography. Mathematics. Natural Philosophy. Chemistry.

The Examination in Chemistry is—Chemistry of the Non-metallic Elements; including their compounds—their chief physical and chemical characters—their preparation—and their characteristic tests.

A Pass Certificate, signed by the Registrar, will be delivered to each Candidate who applies for it, after the Report of the Examiners has been approved by the Senate.

If in the opinion of the Examiners any Candidates in the Honours Division of not more than Twenty years of age at the commencement of the Examination possess sufficient merit, the first among such Candidates will receive an Exhibition of thirty pounds per annum for the next two years; the second among such Candidates will receive an Exhibition of twenty pounds per annum for the next two years; and the third will receive an Exhibition of fifteen pounds per annum for the next two years; such exhibitions are payable in quarterly instalments, provided that on receiving each instalment the Exhibitioner declares his intention of presenting himself either at the two Examinations for B.A., or at the two Examinations for B.Sc., or at the Intermediate Examination in Laws, or at the Preliminary Scientific M.B. Examination, and Intermediate Examination in Medicine, within three academical years from the time of his passing the Matriculation Examination.

Under the same circumstances, the fourth among such Candidates will receive a prize to the value of ten pounds in books, philosophical instruments, or money; and the fifth and sixth will each receive a prize to the value of five pounds in books, philosophical instruments, or money.

Any Candidate who may obtain a place in the Honours Division at the Matriculation Examination in January is admissible to the Intermediate Examination either in Arts or in Science in the following July.

INTERMEDIATE EXAMINATION IN SCIENCE.

The Intermediate Examination in Science will be held in July, 1883.

No Candidate (with the exception of such as have obtained Honours at the Matriculation Examination in the preceding January) is admitted to this Examination within one academical year of the time of his passing the Matriculation Examination.

The Fee for this Examination is £5.

The Examination embraces the following subjects:—Pure and Mixed Mathematics, Inorganic Chemistry, Experimental Physics, and General Biology.

Examination for Honours.

Any Candidate who has passed the Intermediate Examination in Science in all its subjects may be examined at the Honours Examination next following the Intermediate Examination in Science at which he has passed for Honours in (1) Mathematics, (2) Experimental Physics, (3) Chemistry, (4) Botany, and (5) Zoology; unless he has previously obtained the Exhibition in Pure and Mixed Mathematics at the Intermediate Examination in Arts, in which case he will not be admissible to the Examination for Honours in that subject; or unless he has previously obtained an Exhibition at the Preliminary Scientific (M.B.) Examination in either of the subjects which are common to it with the Intermediate Examination in Science, in which case he will not be admissible to the Examination for Honours in that subject.

Candidates for Honours in Chemistry will be examined in Inorganic Chemistry, treated more fully than in the Pass Examination. In addition, they will be examined practically in Simple Qualitative Analysis. This Examination, which will consist of six hours' examination by printed papers and of six hours' practical work, will take place on Thursday and Friday (with Saturday if necessary) in the same week with the Examination for Honours in Mathematics, commencing on each day at 10 a.m.

In the Examination for Honours, the Candidate, not being more than 22 years of age at the commencement of the Pass Examination, who most distinguishes himself in Mathematics, will receive an Exhibition of £40 per annum for the next two years.

B.SC. EXAMINATION.

The B.Sc. Examination will be held in October.

Candidates for this Examination are required to have

passed the Intermediate Examination in Science at least one academical year previously.

The Fee for this Examination is £5.

The regulations are framed with the view of allowing the candidate to select *any three* of the following nine subjects:—

1. Pure Mathematics.
2. Mixed Mathematics.
3. Experimental Physics.
4. Chemistry.
5. Botany, including Vegetable Physiology.
6. Zoology.
7. Animal Physiology.
8. Physical Geography and Geology.
9. Mental and Moral Science.

Examination for Honours.

Any Candidate who has passed the B.Sc. Examination, and has not previously passed the B.A. Examination, may be examined at the Honours Examination next following the B.Sc. Examination at which he has passed, for Honours in (1) Mathematics, (2) Mental and Moral Science, (3) Experimental Physics, (4) Chemistry, (5) Botany, (6) Zoology, (7) Physiology, (8) Physical Geography and Geology; provided that he shall have gone through the Pass Examination in the corresponding subject or subjects immediately before. And any Bachelor of Arts who has passed the B.Sc. Examination may under the same conditions be examined for Honours in one or more of the above mentioned subjects, unless he have previously obtained a Scholarship at the B.A. Examination in either of the first two of those subjects, in which case he shall not be admissible to the Examination for Honours in that subject.

The examination for Honours in Chemistry will take place on Monday and Tuesday in the week following the Examination for Honours in Mathematics; on Monday by printed papers (chiefly on Organic Chemistry), and on Tuesday by practical exercises in Simple Qualitative and Quantitative Analysis.

The candidate, being not more than 23 years of age, who most distinguishes himself in Chemistry, will receive £50 per annum for the next two years, with the style of University Scholar.

DOCTOR OF SCIENCE.

The examination for the Degree of Doctor of Science takes place annually within the first twenty-one days of June, and the examination in each branch occupies four days.

No candidate is admitted to the examination for the Degree of D.Sc. until after the expiration of two Academical Years from the time of his obtaining the Degree of B.Sc. in this University, unless he shall have passed the B.Sc. Examination in the First Division at least two Academical years subsequently to having passed the Intermediate Examination in Science, in which case he shall be admitted to the examination for the Degree of Doctor of Science at the expiration of *one* Academical Year from the time of obtaining his B.Sc. Degree.

The Fee for this Examination is £10.

Every candidate for the degree of D.Sc. is examined in some one or more of the various branches of Physical, Biological, Geological and Palæontological, or Mental Science, to be selected by himself; and no candidate is approved by the examiners unless he has shown a thorough practical knowledge of the principal subject and a general acquaintance with the subsidiary subject or subjects, specified as belonging to the branch so selected. He is expected to be so fully conversant with the principal subject he may select as to be able to go through any examinational test (whether theoretical or practical) of his acquirements in it that can be fairly applied. Candidates, when giving notice, must specify the branch or branches in which they desire to be examined.

BRANCH IV. OF PHYSICAL SCIENCE.
INORGANIC CHEMISTRY.

Principal Subject—Inorganic Chemistry.

Subsidiary Subjects—Either Organic Chemistry; or Mineralogy, Crystallography, and Chemical Technology in its relations to Inorganic Chemistry.

BRANCH V., ORGANIC CHEMISTRY.

Principal Subject—Organic Chemistry.

Subsidiary Subjects—Either Inorganic Chemistry; or Chemical Technology in its relations to Organic Chemistry, and the Chemistry of Animal and Vegetable Life.

PRELIMINARY SCIENTIFIC (M.B.) EXAMINATION.

This examination will be held in July, 1883.

No Candidate is admitted to this examination until he has passed the Matriculation Examination,* and notice must be given to the Registrar at least 14 days before the commencement of the examination. The fee for this examination is five pounds.

Candidates for the degree of M.B. are strongly recommended by the Senate to pass the Preliminary Scientific Examination before commencing their regular medical studies; and to devote a preliminary year to preparation for it according to the following programme:—Winter Session: Experimental Physics; Chemistry (especially Inorganic); Zoology. Summer Session: Practical Chemistry (Inorganic); Botany.

Any candidate who has passed the Preliminary Scientific (M.B.) Examination, may be examined at the Honours Examination next following the Preliminary Scientific Examination at which he has passed, unless he has previously obtained an Exhibition in any one of the subjects at the First B.Sc. Examination, in which case he is not admissible to the Examination for Honours in that subject.

Candidates for Honours in Chemistry are examined in Inorganic Chemistry, treated more fully than in the Pass Examination. In addition they are examined practically in Simple Qualitative Analysis.

EXAMINATION IN SUBJECTS RELATING TO PUBLIC HEALTH.

A Special Examination will be held in December in subjects relating to public health.

No candidate is admitted to this Examination unless he has passed the Second Examination for the Degree of Bachelor of Medicine in this University at least one year previously; nor unless he shall have given notice of his intention to the Registrar at least two calendar months before the commencement of the Examination.

The Fee for this Examination is £5.

GILCHRIST SCHOLARSHIPS.

1. A Scholarship of the value of Fifty Pounds per annum, and tenable for three years, is annually awarded to the Candidate from the Royal Medical College, Epsom, who at the June Matriculation Examination stands highest among the Candidates approved by the Head Master of that Institution, and who passes either in the Honours List or in the First Division; on condition of his prosecuting his studies during the tenure of his Scholarship with a view to Graduation in one of the Faculties of the University of London.—Particulars may be obtained on application to the Secretary of the Royal Medical College, 37, Soho Square, W.

2. A similar amount is annually offered to Candidates intending to pursue, at Owens College, Manchester, their studies for Graduation in one of the Faculties of the University of London; a single Scholarship of Fifty Pounds per annum for three years being awarded to the

* Candidates who pass in all the subjects of the Preliminary Scientific (M.B.) Examination, and also pass at the same time in the Pure Mathematics of the Intermediate Examination in Science, or who have previously passed the Intermediate Examination in Arts, are admissible to the B.Sc. Examination.—One Fee of £5, paid on entering for the Preliminary Scientific Examination also admits a Candidate to the Mathematics of the Intermediate Examination in Science, if taken at the same time.

highest of those Candidates at the June Matriculation Examination who shall have been previously approved by the Principal of Owens College, provided that he pass in the Honours Division; or, in case no Candidate should so pass, two Scholarships, each of Twenty-five Pounds per annum, being awarded to the two Candidates as afore-said who shall stand highest in the First Division.—Particulars may be obtained on application to the Principal of Owens College, Manchester.

3. A Scholarship of Fifty Pounds per annum, tenable for three years, is also annually awarded to that Candidate in the Honours Division at the June Matriculation Examination who shall stand highest of the Candidates previously approved by the Principal of University College, Bristol; and who intends to study at that College with a view to graduation in one of the Faculties of the University of London. (N.B.—This Scholarship is open to Women.) Further particulars may be obtained on application to the Principal of University College, Bristol.

Particulars of the Colonial and Indian Scholarships may be obtained on application to the Secretary of the Gilchrist Educational Trust, 4, Broad Sanctuary, Westminster, S.W.

UNIVERSITY OF OXFORD.

Waynflete Professor of Chemistry.—W. Odling, M.A., F.R.S.

Professor of Mineralogy.—N. S. Maskelyne, M.A., F.R.S.

Every Student must reside in one or other of the Colleges or Halls, or in licensed lodgings, for a period of three years, passing at least two examinations in Arts, and one in either Mathematics, Natural Science, Law, Modern History, or Theology, when, if he obtain a first, second, or third class, he can take his B.A. Degree; if he do not gain such honour he has to pass a third examination in *Literis Humanioribus*.

The fee for students working in the Laboratory for three days in the week during the Term is £3; for students working every day, £5.

Scholarships of about the value of £75 are obtainable at Christ Church, Magdalen, and other colleges, by competitive examination in Natural Science.

More detailed information may be obtained from the University Calendar; from the professors; from E. Chapman, Esq., M.A., Frewin Hall; and from the Sub-Librarian in the Radcliffe Library or the Museum.

UNIVERSITY OF CAMBRIDGE.

Professor of Chemistry.—G. D. Liveing, M.A., F.R.S.

Jacksonian Professor of Natural and Experimental Philosophy.—J. Dewar, M.A., F.R.S.

The Student must enter at one of the Colleges, or as a Non-collegiate Student, and keep terms for three years by residence in the University. He must pass the previous examination in Classics and Mathematics, which may be done in the first or second term of residence, or, through the Oxford and Cambridge Schools Examination Board, or through the Senior Local Examinations, before commencing residence. He may then proceed to take a Degree in Arts, either continuing mathematical and classical study, and passing the ordinary examinations for B.A., or going out in one of the Honour Triposes.

The scholarships, ranging in value from £20 to £80 a year, are chiefly given for mathematical and classical proficiency. Scholarships are given for Natural Science in Trinity, St. John's, St. Peter's, Clare, Christ's, Sidney, Pembroke, Caius, and Downing Colleges; the examinations being at Easter, and in June and October.

The Chemical Laboratory of the University is open daily for the use of the Students. The Demonstrators attend daily to give instructions.

Non-collegiate Students are allowed to attend certain of the College Lectures and all the Professors' Lectures, and have the same University status and privileges as the

other Students. They are under the superintendence of the Rev. R. B. Somerset, Orford House, Cambridge, from whom further information may be obtained.

The following are the Lectures on Chemistry for the ensuing Academical Year:—

MICHAELMAS TERM, 1883.

General Course, by the Professor of Chemistry, on Tuesdays, Thursdays, and Saturdays, at 12 noon. Begin Oct. 11.

Physical Chemistry (Advanced), by the Jacksonian Professor, on Mondays, Wednesdays, and Fridays, at 12 noon. Begin Oct. 15.

Elementary Organic Chemistry, by Mr. Main, at St. John's College, on Tuesdays, Thursdays, and Saturdays, at 11 a.m. Begin Oct. 13.

Metals, by Mr. Pattison Muir, Caius College, Monday, Wednesday, and Friday, at 10 a.m. Begin Oct. 12.

Organic Chemistry (advanced), by Mr. Pattison Muir, Caius College, Tuesdays, Thursdays, and Saturdays, at 10 a.m. Begin Oct. 11.

Elementary Physical Chemistry, by Mr. Scott, on Mondays, Wednesdays, and Fridays, at 1 p.m. Begin Oct. 15.

Catechetical Lectures, by Mr. Lewis, at Downing College, on Mondays, Wednesdays, and Fridays, at 9 a.m. Begin Oct. 12.

Spectroscopic Analysis, by the Professor of Chemistry, on Tuesdays, Thursdays, and Saturdays, at 12 noon. Begin Oct. 18.

Practical Chemistry, by the Demonstrators of Chemistry. University Laboratory. Also at St. John's, Caius, and Sidney Colleges. Daily. Begin Oct. 11.

LENT TERM, 1883.

General Course continued, by the Professor of Chemistry, on Tuesdays, Thursdays, and Saturdays, at 12 noon. Begin Jan. 24.

Organic Chemistry, by the Jacksonian Professor, on Mondays, Wednesdays, and Fridays, at 12 noon. Begin Jan. 25.

General Course of Chemistry, by Mr. Main, at St. John's College, on Tuesdays, Thursdays, and Saturdays, at 11 a.m. Begin Jan. 26.

Non-metallic Elements, by Mr. Pattison Muir, at Caius College, on Mondays, Wednesdays, and Fridays, at 10 a.m. Begin Jan. 25.

General Principles of Chemistry (advanced), by Mr. Pattison Muir, Caius College, on Tuesdays, Thursdays, and Saturdays, at 10 a.m. Begin Jan. 26.

Elementary Organic Chemistry, by Mr. Scott, on Mondays, Wednesdays, and Fridays, at 1 p.m. Begin Jan. 25.

Catechetical Lectures, by Mr. Lewis, at Downing College, on Mondays, Wednesdays, and Fridays, at 9 a.m. Begin Jan. 25.

Chemical Philosophy, by Mr. Heycock, King's College, on Mondays and Wednesdays, at 10 a.m.

Chemistry practically applied to Agriculture, by Mr. Robinson, on Mondays, Wednesdays, and Fridays, at 11 a.m. Begin Jan. 25.

Practical Chemistry, at the University Laboratory, daily. Begin Jan. 25. And at St. John's, Caius, and Sidney Colleges, daily. Begin Jan. 21.

EASTER TERM, 1883.

Elementary Chemistry, by a Demonstrator, on Mondays, Wednesdays, and Fridays, at 12 noon. Begin April 25.

General Course continued, by Mr. Main, at St. John's College, on Tuesdays, Thursdays, and Saturdays, at 11. Begin April 24.

Non-Metals (continued) and Organic Chemistry (Elementary), by Mr. Pattison Muir, at Caius Laboratory, on Mondays, Wednesdays, and Fridays, at 10 a.m. Begin April 24.

General Principles (continued), by Mr. Pattison Muir, Caius College. Tuesdays, Thursdays, and Saturdays, at 10 a.m. Begin April 24.

Gas Analysis, by Mr. Scott, on Mondays, Wednesdays, and Fridays, at 12 noon. Begin April 28.

Catechetical Lectures, by Mr. Lewis, Downing College, on Mondays, Wednesdays, and Fridays, at 9 a.m. Begin April 25.

Practical Chemistry, at the University Laboratory, daily. Begin April 24. Also at St. John's College. Begin April 16. Also at Caius College. Begin April 23. Also at Sidney College. Begin April 24.

KING'S COLLEGE.

(DEPARTMENT OF ENGINEERING AND APPLIED SCIENCE.)

Professor of Chemistry.—C. L. Bloxam, F.C.S.

Demonstrator of Practical Chemistry.—J. M. Thomson, F.C.S.

Assistant Demonstrator.—G. S. Johnson, F.C.S.

On Tuesday and Friday at 10.20 a.m. Students of the First Year are admitted to the Course of Theoretical and Applied Chemistry. The Course commences with a View of the Forces which concur to the production of Chemical Phenomena, after which the laws of Chemical Attraction are discussed, and the Non-metallic elements and their principal Compounds are described.

The Metals and their principal compounds are next examined, care being taken to point out the applications of the Science to the Arts; and the processes of the different Manufactures, of Metallurgy, and of Domestic Economy, are explained and illustrated.

Examinations of the Class, both *vivâ voce* and by written papers, are held at intervals during the course at the usual Lecture hour.

Second Year.—Students attend in the Laboratory twice a week, on Tuesday and Friday, at 10.20, and they go through a course of Manipulation in the most important operations of Chemistry, including the first steps of Analysis.

Any Student of this Department may be admitted to this Class at any period of his study on payment of an extra fee.

Experimental and Analytical Chemistry in the Laboratory.—The object of this Class is to afford to Students who are desirous of acquiring a knowledge of analysis, or of prosecuting original research, an opportunity of doing so under the superintendence of the Professor and Demonstrator; Students may enter, upon payment of extra Fees, at any time except during the vacation, and for a period of one, three, six, or nine months, as may best suit their convenience. The laboratory hours are from ten till four daily, except Saturday, on which day the hours are from ten till one.

In addition to the Laboratory Fee, each Student defrays the expenses of his own Experiments. The amount of this expense, which is comparatively trifling, is entirely under his own control.

Special hours and fees are arranged for the convenience of such Third Year Students as wish to study Analytical Chemistry.

Fees.—Chemistry per term, £3 3s. od.; per ann., £8 8s. od.; Practical Chemistry per term, £4 4s. od.; per ann., £10 10s. od.; Experimental and Analytical Chemistry—One Month (daily attendance), £4 4s. od.; Three Months (daily attendance), £10 10s. od.; Six Months (daily attendance), £18 18s. od.; Nine Months (daily attendance), £26 5s. od. A student taking a month's ticket may attend daily during 1 month, or 3 days a week during 2 months, or 2 days a week during 3 months.

Rules as to Admission of Students.

I. The Academical Year consists of Three terms: Michaelmas Term, from beginning of October to the week before Christmas; Lent Term, from the middle of January to the week before Easter; Easter Term, from Easter to the beginning of July.

II. The days fixed for the Admission of New Students in the Academical Year 1883-84, are Tuesday, October 2, Tuesday, January 15, and April 22.

METALLURGY.

Professor.—A. K. Huntington, F.I.C., F.C.S., &c.

The following subjects are treated of in the Lectures: The Selection and Economic Preparation of Fuel and of Refractory Materials; the Methods by which Metals are obtained from their ores, and the means by which they are rendered suitable for the various requirements of the Arts.

Particular attention is made to the study of the Nature and Properties of Metals and Alloys available for Constructive Purposes.

In the Metallurgical Laboratory, which is always open during College hours, the relation between the Chemical Composition of Metals and their Mechanical Properties may be studied by the aid of Testing Machinery. The study of the other subjects above referred to, and also of Assaying, is carried on under the direction of the Professor.

Fees.—Lectures only, £3 3s. Practice (including Lectures), for one month, £6 6s.; two, £11 11s.; three, £15 15s.; six, £27 6s.; nine, £37 16s.

EVENING CLASSES.

Classes for Evening Instruction in various subjects are held during the months from October to March, inclusive, and during the months of April, May, and June. The next Winter Course will begin on Monday, October 8th, and will terminate on Friday, March 28th, 1884, the last fortnight being devoted to examinations. Many of these classes have special reference to the B.A. and Matriculation Examinations of the University of London.

Agriculture.—A Course of Lectures on this subject will be given during the ensuing Winter by Mr. Frederick James Lloyd, F.C.S., of the Royal Agricultural Society of England. The Lectures will be given on Thursday Evenings at 6 p.m., beginning October 10th, 1883. Fee, £1 11s. 6d. for the Course, to be paid in advance at the College Office.

UNIVERSITY COLLEGE.

FACULTY OF SCIENCE.

Professor.—Alex. W. Williamson, Ph.D., LL.D., F.R.S.

Lecturers.—Henry Forster Morley, M.A., D.Sc.; R. T. Plimpton, Ph.D.; and Temple Orme, F.C.S.

The following classes are included in this department, viz.:—

I. Lectures illustrated by experiments and accompanied by frequent exercises.—General course, exercise course, higher organic courses, matriculation course, course of quantitative analysis.

II. Practical classes in which experiments are performed by the students, and substances examined by them.—Analytical and Research Laboratory, practical class, senior practical class, elementary chemistry (women), summer matriculation course.

General Course.

Lectures on examinations daily, except Saturday, 11 to 12, up to the last week in March.

Fee, for the course, £7 7s.; perpetual, £9 9s.; for the half course, £4 4s.; for the organic course alone, £2 2s.

Students of this class are recommended to attend the exercise class at the same time.

Exercise Class.

Tuesdays and Thursdays at 9, from October till the first week in February. First meeting October 9th.

Fee: £1 11s. 6d.

Matriculation Course.

This course consists of about forty lectures of the general course of chemistry, and about twenty meetings of the exercise class. Students will attend the exercise class throughout the first term, and will receive instructions from time to time from the lecturer as to which meetings of the general course they should attend.

Fee: For forty lectures of the general course, £3 3s.; for the exercise class during the first term, £1 1s.

Practical Chemistry.

Fee: For the course (including cost of materials), £5 5s.; for a second course, £3 3s.

About forty lessons of one hour each, on Tuesday, Wednesday, Thursday, and Friday, from 11 to 12, beginning in the first week in May.

The course includes the practical chemistry required at the Preliminary, Scientific, and Intermediate B.Sc. Examinations of the University of London.

Senior Practical Class.

This course consists of about twenty lectures of two hours each, on Mondays and Saturdays, from 10 to 12.

Fee:—(Including cost of materials), £5 5s.; for a second course, £3 3s.

The course includes the practical chemistry required at the Intermediate M.B. Examination of the University of London.

Students who have matriculated in January and wish to proceed to the Preliminary, Scientific, and Intermediate Science Examinations in the following July, will enter for the Practical Class, and can obtain special instruction in the necessary parts of Theoretical Chemistry, for which purpose they should apply to the Professor of Chemistry

Organic Chemistry.

There are three classes of organic chemistry; in each of them exercises will be given on the subject of each lecture.

The junior class, which forms part of the general course of chemistry, will include the subjects required by candidates for the Intermediate M.B. Pass Examination, and for the diplomas of the College of Physicians and Society of Apothecaries.

The senior class will include the additional subjects required by candidates for Honours in Chemistry at the Int. M.B. Examination.

Candidates for the B.Sc. Pass and Honours are advised to enter for the whole course; but if they have previously acquired a general knowledge of the subject they may omit the junior class.

Fees:—For the junior class, £2 2s.; for either senior or higher senior class, £2 12s. 6d.; for two classes, £4 4s.; for the session, £6 6s.; perpetual £9 9s.; perpetual admission to two specified classes, £6 6s.

Summer Matriculation Class (Men).

On Tuesdays, Thursdays, and Fridays, from 9 to 10.

The course includes those parts of chemistry which are required for the Matriculation Examination of the University of London, and is specially adapted for those who have no previous knowledge of the subject. It consists of about 25 lectures and of at least 10 tutorial lessons.

The course includes also 20 lessons in practical chemistry.

The lectures will begin on Friday, March 21st, the practical lessons in the first week in May.

Fee, including cost of materials and apparatus, £5 5s.

Elementary Chemistry (Women).

Lectures:—Wednesday and Friday, from 4 to 5.

A class of elementary chemistry, including the subjects required for Matriculation, will be given during the second and third terms, commencing Wednesday, January 9th.

Fee:—For the course, including the cost of apparatus and materials, £4 4s.

Analytical and Practical Chemistry.

When accompanied or preceded by attendance on the lectures on Chemistry, the Laboratory Course qualifies Students in the application of Chemistry to the Manufacturing Arts, Metallurgy, Medicine, or Agriculture, &c. Instruction is given in the principles and processes of gas-analysis.

The Laboratory and offices are open daily from 9 a.m. to 4 p.m., from October until the middle of July, with a short recess at Christmas and at Easter. Saturday, from 9 to 2.

Fees, for the Session, 25 guineas; six months, 18 guineas; three months, 10 guineas; one month, 4 guineas; exclusive of the expense of materials.

A Gold Medal and Certificates of Honour are competed for by students entered for the session.

Quantitative Analysis.

A course of twenty lectures on quantitative analysis will be given during February, March, and April, commencing in the first week of February. Fee, £1 11s. 6d.

Chemical Technology.

Professor CHARLES GRAHAM, D.Sc., F.I.C.

Assistant.—C. J. Wilson, F.C.S.

The Course of instruction in this Department is designed to afford to Students who propose to devote themselves to industrial pursuits in which Chemistry plays an important part, or to prepare themselves for the profession of Consulting Chemist, the instruction essential for their success in their future line of work. It will also be found of great value in two of the branches (Organic and Inorganic Chemistry) in which the Degree of Doctor of Science can be taken at the University of London.

In the Session 1883-84, it is proposed to treat of the following subjects:—

Heating and Lighting.

Metallurgy.

The Chemistry of the Alkali trade.

Chemistry of Brewing.

Agricultural Chemistry.

Fees—for each Course, £2 2s.; for two Courses, £3 3s.; for the five Courses, £5 5s.

Laboratory of Chemical Technology.

The instruction in the Laboratory of Chemical Technology will consist of the examination and valuation of raw materials used, and of the final products obtained in various manufacturing industries, and of experimental examination of the processes employed in the arts and manufactures.

The Laboratories are open daily from 9 a.m. to 4 p.m., from the 6th of October until the middle of July, with a short recess at Christmas and at Easter.

Fees—for the Session, 25 guineas; six months, 18 guineas; three months, 10 guineas; one month, 4 guineas; exclusive of the expense of materials.

NORMAL SCHOOL OF SCIENCE AND ROYAL SCHOOL OF MINES.

Professor.—E. Frankland, Ph.D., D.C.L., F.R.S.

Assistant Professor.—F. R. Japp, M.A., Ph.D.

Demonstrators.—W. R. Hodgkinson, Ph.D., and P. F. Frankland, Ph.D., B.Sc.

Assistants.—G. S. Newth and H. Chapman Jones.

The Normal School of Science at South Kensington is intended, primarily, for the instruction of teachers, and of students of the industrial classes selected by competition in the examinations of the Science and Art Department. The Royal School of Mines is affiliated to the Normal School. Students entering for the Associateship of the School of Mines obtain their general scientific training in the Normal School. Other students are admitted so far as there may be accommodation for them, on the payment of fees fixed at a scale sufficiently high to prevent undue competition with institutions which do not receive State aid. The instruction in the Normal School is arranged in such a manner as to give the Students a thorough training in the general principles of Science, followed by advanced instruction in one or more special branches of Science. The Associateship is granted in certain divisions or lines of study. Students who go through any one of the prescribed courses of instruction and pass the necessary Examinations receive a Certificate of Associateship of the Normal School, or of the Royal School of Mines. But students who are not candidates for the Associateship

are permitted to take up the course of instruction in one or more special branches of science, and on passing the examination receive a Certificate to that effect. The Associateship of the Normal School of Science is given in one or more of the following divisions:—Mechanics, Physics, Chemistry, Biology, Geology, and Agriculture, and the Associateship of the Royal School of Mines in Metallurgy and Mining.

The course of instruction is the same for all the divisions during the first two years, after which it is specialised in accordance with the Scheme detailed in the Prospectus of the School.

The Session is divided into two Terms. The first Term begins about the 1st of October and ends about the middle of February. The second Term begins in the middle of February and ends about the middle of June.

Examinations are held at the end of each course of instruction and at such other periods as may be found necessary. On the results of these examinations the successful candidates are arranged in two classes, first and second. There are also "Honours" examinations for the subjects of the third and fourth years, the successful candidates being placed in order of merit. A student obtains the Associateship who passes in all the subjects of the first two years and of the special division he selects for his Associateship. A student who goes through the prescribed course of instruction in any subject and passes the final examination in it receives a certificate to that effect.

Students who do not wish to attend the lectures are admitted for short periods to the laboratories, at the discretion of the Professors. The fees for the laboratories are £4 per month.

Admission is granted to persons desirous of attending certain courses of the lectures without the laboratory instruction, on payment of the lecture fees.

The fees which are shown in the following table must be paid to the Registrar of the School before the commencement of each course.

	Part I.		Part II.		Part III.		Part IV.	
	Lecs. & Lab.		Lecs. & Lab.		Lecs. & Lab.		Lecs. & Lab.	
	£	£	£	£	£	£	£	£
Chemistry	4	13	15	15				
Physics	5	12	12	12				
Biology with Botany ..	4	8	8		4	8		
Geology with Mineralogy ..		4			8	8		
Mechanics	4	6	8	8				
Metallurgy	2	13	15					
Assaying for Mining Students			10					
Mining	4	6						
Agriculture	4	10						
Astronomy	2							

Mathematics £3 per term. Practical Geometry and Mechanical Drawing £3 per term. Freehand Drawing £1 per term.

Thus the fees for the first two years amount to about £75, and for the remainder of the course for the Associateship they vary from £30 to about £40.

Both the private and the State-aided students are required to furnish themselves with certain instruments and apparatus before the commencement of the courses. These are enumerated in the syllabuses of the several subjects.

Officers of the Army, Navy, and Civil Service, recommended by their respective Departments, are admitted to the Lectures and Laboratories at half the foregoing charges.

Associates of the Normal School of Science and of the Royal School of Mines have the privilege of free admission to the Library and to all the courses of lectures.

Science teachers actually engaged in teaching who have passed in the advanced stage, or in honours, in any subject in the May examination of the Science and Art Department, or in the December examination in Training Colleges, may attend any course of lectures on the payment of £1.

Several valuable Exhibitions, Scholarships, and Prizes are attached to the studentship.

Summer Courses for Teachers.—Short courses of instruction are given annually, about July, in different branches of science for the benefit of teachers of science schools in the country. The courses last three weeks. About 200 teachers are admitted to them, and they receive 2nd class railway fare to and from London, and a bonus towards their incidental expenses of £2 each. (See Science Directory.)

Working Men's Lectures.—Three courses of evening lectures for working men will be given during the session by Professor Goodeve, Dr. Japp, and Mr. Rutley. The admission to each course of six lectures will be 6d. The number of tickets is limited by the size of the lecture theatre.

UNIVERSITY COLLEGE OF WALES, ABERYSTWYTH.

Professor of Chemistry and Experimental Physics.—T. S. Humpidge, Ph.D., B.Sc. (Lond.)

The following courses of lectures will be delivered during the Session 1883-4, commencing on Sept. 13th.

1. *Inorganic Chemistry.*—A course of experimental lectures on the Non-Metals, Metals, and Theoretical Chemistry, Tuesday, Wednesday, and Friday from 12 to 1. Practical Class on Monday, Wednesday, and Friday from 2 to 5 p.m.

2. *Organic Chemistry.*—A course of experimental lectures on the chief organic compounds, and on the laws which govern their production, decomposition, &c.

3. *Experimental Physics.*—A course of experimental lectures, Tuesday, Wednesday, and Friday from 10 to 11.

Fee for all subjects extending over the whole Session, £10. Practical Chemistry, 5s. per term extra.

UNIVERSITY COLLEGE, BRISTOL.

Professor of Chemistry.—W. Ramsay, Ph.D.

Lecturer.—Sydney Young, B.Sc.

DAY LECTURES.

Inorganic Chemistry.

This Course treats of the principles of Chemistry, and of the Chemistry of the Non-Metals and Metals.

Lectures will be given at 9 o'clock on Mondays, Wednesdays, Fridays, and Saturdays during the First and Second Terms.

The lectures will be illustrated with experiments and diagrams.

Examinations will be held from time to time during the courses.

Fee, £4 4s. for two Terms, £3 3s. for one Term.

Special Laboratory Course.

Special instruction will be given on Tuesdays and Thursdays from 4 to 6. The Course is designed for Students entering for elementary examinations in Chemistry, and others to whom the hour may prove convenient.

Fees, £3 3s. for two Terms; £2 2s. for one Term.

Organic Chemistry.

This Course will relate to the more important groups of the Compounds of Carbon.

Lectures will be given during the Second Term on Tuesdays and Thursdays at 9 o'clock; during the Third Term on Tuesdays, Thursdays, and Saturdays at 9 o'clock.

Special Lectures will also be given.

Fee, £3 3s.

Advanced Course.

This Course will be given on Saturdays at 9 o'clock during the first and second Terms, and will be devoted to a more minute consideration of Chemical Theory, as shown in recent researches.

Fee, £2 2s.

Practical Chemistry.—Laboratory Instruction.

The Laboratory will be open daily from 10 a.m. to 5 p.m., except on Saturdays, when it will close at 1 p.m. Instruction will be given in the Laboratory in all branches of Practical Chemistry, including Qualitative and Quantitative Inorganic and Organic Analysis, the preparation of Chemical Products, and Inorganic and Organic Research. Special facilities will be afforded to those who desire to study Practical Chemistry as applied to the different processes employed in the Arts and Manufactures, and in Scouring, Bleaching, and Dyeing. The Laboratory is under the immediate supervision of the Professor and the Lecturer.

Fees in Guineas—

	6 Days a Week.	5 Days a Week.	4 Days a Week.	3 Days a Week.	2 Days a Week.
Per Session	17	15	13	10	7½
„ Two Terms ..	13	11	9	7½	5½
„ One Term ..	7	6	5	4	3
„ Month	3	3	2	2	1½

Students may arrange to divide their days of laboratory work into half-days.

In order that Students may have an opportunity of acquiring some knowledge of Applied Chemistry, excursions to some of the Mines and Manufactories of the neighbourhood will be occasionally made. They will be conducted by the Professor or by the Lecturer.

EVENING LECTURES.

Inorganic Chemistry.

Lecturer.—Sydney Young, B.Sc.

Wednesday and Friday, 8 to 9.

This course will consist of Two Lectures a week during the First and Second Terms; they will be devoted to the consideration of the Principles of Chemistry and Chemical Physics and the Chemistry of the Non-Metallic Elements. A few Lectures at the end of the Course will be devoted to the consideration of the Chemistry of

Metals. Special attention will be paid throughout to those products which have a practical application in the Arts and Manufactures.

Fee, 10s. 6d. for Two Terms; 7s. for One Term.

Technical Chemistry.—Special Courses.

Professor.—W. Ramsay, Ph.D.

First and Second Terms.—A Course of Lectures will be delivered on Tuesday evenings at 8 o'clock, on the Scouring, Bleaching, and Dyeing of Wool, Silk, Cotton, Linen, and Jute. This course is designed to afford information to those engaged in the manufacture and sale of articles made of the above materials. It will imply no previous knowledge of chemistry; but those who purpose to attend it are recommended to enter the Evening Chemistry Classes during the first Term.

Fee, 10s. 6d. for two Terms; 7s. for one Term.

Chemical Scholarship.—Among others, a Chemical Scholarship of £25 is offered for competition.

With the approval of the Council of the Institute of Chemistry students desiring to qualify as Associates may pass through the requisite amount of study at this College, which has also been approved as a centre for the Practical Examination of the Institute.

ROYAL AGRICULTURAL COLLEGE, CIRENCESTER.

CHEMICAL DEPARTMENT.

Professor.—Prof. E. Kinch, F.C.S., F.I.C.

Assistants.—H. H. Robinson, B.A., and Mr. W. James.

Systematic courses of Lectures are given on Inorganic, Organic, and Agricultural Chemistry, illustrated by experiments, and by the collections in the College Museum. They comprise, as preliminary, the laws of Chemical Combination and the general Chemistry of mineral bodies, and of the more frequently occurring bodies of organic origin, with the relationship of their leading

groups; and, finally, the Chemistry of the atmosphere, of soils and manures, of vegetation and animal nutrition, and of Agricultural economy.

In the Laboratory practical instruction is given in the construction and use of apparatus and in Chemical manipulation and analysis, both qualitative and quantitative. After studying the simple operations and the properties of the commonly occurring substances, the Students are taught to analyse a series of compounds, and apply the knowledge thus obtained to the analysis of manures, soils, waters, foods and feeding stuffs, and other substances met with in the ordinary course of Agricultural practice. Chemico-agricultural researches are undertaken by the senior Students under the direction of the Professor and his Assistants.

THE YORKSHIRE COLLEGE, LEEDS.

Professor of Chemistry.—T. E. Thorpe, Ph.D., F.R.S., F.C.S.

Assistant Lecturer.—C. H. Bothamley, F.C.S.

The Session begins October 2nd, 1883.

Students of the Leeds School of Medicine are admitted to any of the classes on payment of the class fees, and are not charged with the College entrance fee.

Lecture Courses.

1. General Course on Inorganic and Organic Chemistry—Monday, Tuesday, Thursday, and Friday, at 4 p.m., from October to the end of the second term. Fee for the Course, £4 4s.

2. Lectures on Laboratory Practice and Chemical Calculation—Wednesday, at 12 noon, during the First and Second Terms. Fee, £1 1s.

3. Lectures on the Chemistry of the Non-Metals—Saturday, at 12, during the First and Second Terms. Fee, 10s. 6d.

Laboratory Courses.

The College Laboratory will be open daily from 9 a.m. to 1 p.m., and from 2 to 5 p.m., except on Saturdays, when it will close at 1 p.m.

Fees for the Session.—Students working six days per week, £17 17s.; four, £13 13s.; three £11 11s.; two, £8 8s.; one, £4 4s.

Class in Practical Chemistry, Saturday mornings, from 9 to 12, during First and Second Terms. Fee £1 11s. 6d.

Practical Chemistry for Medical Students.—On Tuesday and Thursday, from 10 to 12 a.m., from May to July.

Evening Classes.

A Course of twenty Lectures by Mr. C. H. Bothamley, on the Elements of Inorganic Chemistry (the Non-Metals) will begin during the first and second Terms, on Wednesdays, at 8 p.m., beginning October 10. Fee, 10s. 6d.

A Course of Twenty Lectures by Mr. C. H. Bothamley on the Metals will be given during the first and second Terms, on Mondays, at 8 p.m., beginning Oct. 8. Fee, 10s. 6d.

Dyeing Department.

Instructor.—J. J. Hummel, F.C.S.

Lecture Course, with practical work in the Dye-house, for Students who wish to receive, on leaving the College, a certificate of proficiency in Dyeing; such certificate to be obtained by special examination in the several subjects of the Course, the latter extending over a period of two years. Fee, £3 3s.

Scholarships.

For Associates.—The Cavendish Scholarship. Value £50 per annum, tenable for one year.

Advanced Scholarships.—

The Brown Scholarship. Value £35, tenable for two years.

The Akroyd Scholarship. Value £30 per annum, tenable for two years.

Entrance Scholarships.—

The Salt Scholarship. Value £20 per annum, tenable for two years.

The Goodall Exhibition of £15, tenable for two years, The Akroyd Scholarships. One, value £25, and one, value £20, tenable for two years.

The Brown Scholarships. One, value £25, and one, value £20, tenable for two years.

The Clothworkers' Company Scholarships. For Textile Department four Scholarships, and for Dyeing Department two Scholarships, each of the value of £25 per annum, and tenable for one year.

MASON SCIENCE COLLEGE, BIRMINGHAM.

Professor.—W. A. Tilden, D.Sc., Lond., F.R.S.

Assistant Lecturer.—W. W. J. Nicol, M.A., B.Sc., Edin.

Demonstrator.—Thomas Turner, F.C.S.

Elementary Course.

Twenty Elementary Lectures adapted to the requirements of beginners will be given in the Winter Term, and will be repeated after Christmas, on Mondays and Fridays at 12 o'clock. The Second Course will begin on the first Monday in March.

Persons entirely unacquainted with Chemistry are recommended to attend these Lectures before entering for the General Course, which commences in October. Candidates for the Matriculation Examination of the University of London may obtain the instruction they require for that Examination by attending this Course.

General Course.

The General Course of Lectures on Chemistry will be found useful by Students who are afterwards to become Engineers, Architects, Builders, Brewers, or Manufacturers (such as Metallurgists, Alkali, Soap, Manure, Glass, or Cement Makers, Bleachers and Dyers, &c.)

Students preparing for the Intermediate Examination in Science and Preliminary Scientific (M.B.) Examination of the University of London, should attend the Lectures on *Inorganic Chemistry* (Winter and Spring Terms).

Candidates for B.Sc. and Intermediate Examinations in Medicine will in general require only that part of the course (Summer Term) which relates to *Organic Chemistry*.

The full course, extending over three terms, will also satisfy the requirements of Students preparing for the Associateship of the Institute of Chemistry, so far as attendance at lectures on General and Theoretical Chemistry is concerned.

1. From October to March (Winter and Spring Terms). About one hundred lectures on *Inorganic Chemistry and Chemical Philosophy* will be given on Mondays, Tuesdays, Wednesdays, Thursdays, and Fridays, at 10 a.m., commencing Wednesday, October 3rd, 1883. Fee, £3 3s. for a single term, or £5 5s. for the course from October to March.

2. April to June (Summer Term). About forty lectures will be given on *Organic Chemistry*, or the chemistry of the most important series of carbon compounds. This course will include all the subjects required for the Intermediate Examination in Medicine of the University of London. Lecture Days.—Monday, Tuesday, Wednesday, and Thursday, at 10 a.m. Fee, £2 2s.

In both these courses the instruction at least once a week will take the form of class teaching, and exercises will be set which students will be expected to work at home.

Laboratory Practice.

The College Laboratory will be open daily from 9.30 to 5, except on Saturdays, when it will be closed at 1 p.m.

Candidates for Intermediate Examination in Science, Preliminary Scientific (M.B.), B.Sc., and Intermediate Examination in Medicine of the University of London, may obtain in the Laboratory of the College the instruc-

tion necessary. The three months Course of Practical Chemistry for the B.Sc., Edinburgh, in the department of Public Health may be taken in the Mason College Laboratory.

The Ordinary Course for Medical Students is given on Tuesdays and Thursdays from 2 to 4 p.m. throughout the Summer Term.

Fees:—

	All day.	Three hours per day.
One Term	7 guineas	4½ guineas.
Two Terms	13 „	8½ „
Three Terms	18 „	12 „

A Course of short demonstrations and exercises will be given by the Professor or one of his Assistants once a week. All first-year Students will be required to attend, unless exempted for special reasons by the Professor. No Fee.

Metallurgy.—A Course of about twenty Lectures will be given in the Winter and Spring Terms (October to March), on Tuesday Afternoons at 2 o'clock, on the Principles and Practice of Metallurgy. Fee for the Course, £1 1s.

Arrangements will be made in the Chemical Laboratory or giving instruction in Practical Metallurgy.

Excursions.

During previous Sessions permission has been obtained to visit some of the great factories in or near Birmingham, in which chemical and metallurgical industries are carried on. Students have thus had most valuable opportunities of gaining a practical acquaintance with some branches of Applied Science. The privilege thus courteously granted by several manufacturers will, it is hoped, be enjoyed in every future Session. The excursions will be conducted by the Professor.

UNIVERSITY COLLEGE, LIVERPOOL.

Professor.—Campbell Brown, D.Sc.

Assistant.—H. Ll. Snape.

The Session commences October 1st.

Students desirous of having a thorough theoretical and practical acquaintance with Technical Chemistry, or who intend to adopt Chemistry as a profession, must devote at least three years to special study. They ought to have an ordinary school acquaintance with English Composition and Latin, and must be proficient in Arithmetic and the elements of Algebra.

They are recommended to adopt the following curriculum:—

First Year.—Chemistry—Course of Lectures on Theoretical Chemistry during the Autumn and Lent Terms; Chemical Laboratory, two or three days a week, during the Lent and Summer Terms; and the Practical Chemistry Class during the Summer Term. Mathematics, Pure and Applied, Physics or Geology, French or German.

Second Year.—Chemistry—Second Attendance on General Lecture Course, if necessary; Lectures on Organic Chemistry in the Summer Term. Chemical Laboratory, three days per week. Physics, Mathematics, German or French.

Third Year.—Any of the above-mentioned lectures which have not been attended. Chemical Laboratory, four or five days per week. Physical Laboratory, one day per week.

Special Certificates will be granted to those Students who pass through the above or a similar curriculum, and who perform their work and pass the periodical examinations to the satisfaction of the Professors; but these Certificates of Proficiency will only be given to such as can perform Practical Work in a reliable manner. Remunerated appointments are occasionally offered to efficient Students of the third year.

The Laboratory is opened for Students from 10 a.m. to 4.30 p.m. daily, on Saturdays from 10 to 1 only.

The Prospectus containing full particulars may be obtained of Adam Holden, 48, Church St., Liverpool, price 6d.

LIVERPOOL COLLEGE OF CHEMISTRY.

Principal.—George Tate, Ph.D., F.G.S., F.C.S.

The Laboratories are open daily from 10 to 5, and also during the winter and spring months, on Tuesday and Wednesday evenings, from 6.30 to 9.30. Evening lectures will be delivered during the winter session by Dr. Tate on Chemistry, Metallurgy, and the Chemistry of Brewing. Arrangements will be made during the session for the members of the classes to visit Chemical and Metallurgical works in the district. Full prospectuses may be had on application.

UNIVERSITY OF DURHAM.

COLLEGE OF PHYSICAL SCIENCE, NEWCASTLE.

Professor of Chemistry.—P. Phillips Bedson, D.Sc., F.C.S.

Demonstrator.—J. T. Dunn, M.Sc.

The Session will commence on October 1st, 1883.

Junior Division.—General Principles of Chemistry. History of the Non-Metallic Elements. History of the Metals and their more important Native and Artificial Compounds. Principles of Qualitative Analysis. Mondays, Wednesdays, and Fridays, at 12.5 p.m. *Senior Division.*—Organic Chemistry. Elements of Applied Chemistry. Tuesdays and Thursdays, at 11. Fee, £5 5s.

Practical Chemistry.—The Laboratory is open from 10 a.m. to 1 p.m., and from 2 to 5 p.m., except on Saturdays, when it closes at 1 p.m. *Laboratory Fees.*—Students working six days per week, £5 5s. per term; alternate days, £3 3s.; one day per week, £1 1s.

Courses of Study.—Students will be distinguished into Regular and Occasional. Regular Students will be required to follow such a course of study in the subjects professed in the College as will enable them to pass the Examinations for the title of Associate in Physical Science. Occasional Students will attend such classes as they may select. Every candidate for admission as a regular student must pass an examination on entrance, in reading, writing from dictation, English or Latin Grammar, arithmetic (including decimals), and geography. Registered students in medicine are exempted from this examination, or students who produce a certificate of having passed either of the two following examinations:—

1. Durham Senior Examination of Persons not Members of the University, held in June.
2. Durham Examination for Students in Arts in their first year, or any examination of a similar nature that may be accepted by the Council.

Associateship in Physical Science.—Every candidate for the Associateship in Physical Science, will be required to satisfy the examiners in three, at least, of the four subjects,—Mathematics, Physics, Chemistry, and Geology,—in an examination, to be held at the beginning of his second year.

The examination in Chemistry comprises:—General Principles of Chemistry. Elements of Inorganic Chemistry. Elements of Qualitative Analysis, including a Practical Examination.

The examination in Chemistry for Candidates at the end of their second year comprises:—Elements of Organic Chemistry and Applied Chemistry. Advanced Qualitative Analysis, including a Practical Examination. Elements of Quantitative Analysis.

Exhibitions.—Three Exhibitions of the value of £25, £15, and £10 respectively will be awarded in October next to Candidates desirous of attending the first year course of study in the College.

Candidates must send their names to the Secretary, on or before the 22nd of September, and specify, at the same time, the special subject in which they desire to be examined.

The examination will be held at the College, and will commence on Monday, the 1st October.

Two Exhibitions of £15 each will be awarded at the next

examination of "Persons not members of the University," which will be held at Durham, and elsewhere, in June next.

Scholarships.

T. Y. Hall Scholarship.—This Scholarship, of the yearly value of £20, tenable for three years by students attending two or more of the classes, will be awarded on the result of the first examination for the Associateship in Science.

Charles Mather Scholarship.—This Scholarship, of the yearly value of about £40, will be awarded on the result of the Final Examination for the Associateship in Science, and is tenable for one year from the time of obtaining the Associateship in Science, provided the Scholar continues his studies in the College to the satisfaction of the Professors.

Nathaniel Clark Scholarship.—This Scholarship, of the value of £15 for one year, will be awarded in October to that student who shall pass the First Examination for the Associateship in Science, and who shall be most distinguished in Chemistry and Geology. The Scholar will be required to attend the classes of Chemistry and Geology, so as to be qualified to take those subjects for the Final Examination for the Associateship in June next.

OWENS COLLEGE, MANCHESTER.

Professor and Director of the Chemical and Metallurgical Laboratories.—H. E. Roscoe, B.A., Ph.D., F.R.S., F.C.S.

Professor of Organic Chemistry.—C. Schorlemmer, F.R.S.

Demonstrators and Assistant Lecturers.—Watson Smith, F.C.S., Harry Baker, F.C.S., Arthur Smithells, B.Sc., and W. Bott, Ph.D.

The Session begins on October 2, 1883, and ends on June 27, 1884.

Technological Chemistry.

Persons desiring to attend this course will be required to enter the College under the ordinary conditions of studentship.

The object of this course is to offer to students intending to devote themselves more especially to Applied Chemistry as complete a training as the College can provide in those branches of instruction which form the scientific foundation of the subject.

The complete course of instruction extends over four years, and embraces the following subjects:—

First Year.—Chemistry Lectures, Junior and Tutorial classes. Chemical Laboratory, 2 days per week, and Analytical Chemistry Lectures class. Mathematical class, Section I. Experimental Mechanics. Geology (Stratigraphical). French or German. Geometrical Drawing Lectures (evening class). Mechanical Drawing, Practical (evening class).

Second Year.—Chemistry Lectures, Junior,* Senior, and Tutorial classes. Chemical Laboratory, 3 days per week. Technological Chemistry Lectures. Experimental Physics or Mineralogy Lectures. German or French. Geometrical Drawing Lectures (evening class). Mechanical Drawing, Practical (evening class).

Third Year.—Chemistry Lectures, Senior* and Tutorial classes. Organic Chemistry Lectures. Chemical Philosophy. Chemical Laboratory, 3 days per week. Technological Chemistry Lectures (second course). Physical Laboratory, 1 day per week, or Advanced Mineralogy Lectures and Practical Course. Mechanical Drawing, Practical (evening class).

Fourth Year.—Organic Chemistry Lectures.* Technological Chemistry Lectures (third and fourth courses). Chemical Laboratory, 4 days per week. Mechanical Drawing, Practical (evening class).

* Students who gain a place in the First or Second class in the annual examinations will be excused a second attendance on these classes.

Fees.—First year (including College Admission and Library fees), £29 5s.; second year, £27 13s.; third year, £28 10s. 6d.; fourth year, £24 10s.

The aggregate of the fees in each year will vary slightly according to the particular class selected in French or German, or to the choice made in respect of the other alternatives proposed.

When a student is excused a second attendance on any of the Chemistry Lecture Courses the fee will be reduced accordingly.

Certificates will be granted to students on the successful completion of this course. Attendance on the full course of four years is expected of candidates for the Certificate, but students may obtain exemption (on cause shown) from the first or the first and second year's course. Students so excused will nevertheless be required to undergo examination in all the subjects specified.

The Certificate will state in which subjects the candidate has gained Honours, and in which he has merely satisfied the Examiners.

Entrance Exhibitions.

I. Victoria Exhibition (Classics), £15.

II. Wellington Exhibition (Greek Testament), £15.

III. Dalton Mathematical Exhibition, £15. Renewable for a second year.

IV. Grammar School Scholarship, £17 per annum, tenable for three years; open to scholars of the Manchester Grammar School only.

V. Two Oxford and Two Cambridge Local Exhibitions, giving free admission to lecture classes in the College for one year, and renewable for two years further, are awarded annually on the results of the Oxford and Cambridge Examinations held in Manchester in December, 1880, and June, 1881.

VI. Gilchrist Scholarship, £50 per annum, tenable for three years; awarded on the results of the Matriculation Examination of the University of London, in June, 1881.

VII. Rumney Scholarship, £45 per annum, tenable for three years.

VIII. Ramsbottom Scholarship, £40 per annum, tenable for two years. The next competition will take place in 1882.

IX. Crace-Calvert Scholarship, £25 per annum, tenable for two years. The next competition will take place in June, 1882. This scholarship is open only to duly qualified members of the Evening Chemistry Classes.

Fellowship.

The Langton Fellowship, £150 per annum, tenable for three years. Candidates must have been students in the College for not less than three sessions, and must during their studentship or within one year after the close of the same have obtained a degree of some University of the United Kingdom, or been elected to the Associateship of the College. The next competition for the Fellowship will take place in 1881.

Scholarships.

The following (except the Shakspeare Scholarship) are open to the competition of students of the College only.

I. Victoria Scholarship (Classics), £40 per annum, tenable for two years.

II. Wellington Scholarship (Greek Testament), £20 per annum, tenable for two years.

III. Shuttleworth Scholarship (Political Economy), £50, tenable for one year.

IV. Shakspeare Scholarship (English Language and Literature), £40 per annum, tenable for two years.

V. Bradford History Scholarship, £45 per annum, tenable for one year, and renewable for a second year.

VI. Dalton Chemical Scholarships, two, each of £50 per annum, tenable for two years.

VII. Dalton Mathematical Scholarships, one Senior and one Junior Scholarship, of the value of £25 each, tenable for one year.

VIII. Platt Scholarships (Physiology), two, one offered annually, £50 per annum, tenable for two years. (Two Platt Physiological Exhibitions of £20 each are offered for competition at the end of the Session 1880-1, open to first and second years' students in Physiology.)

IX. Heginbottom Physical Scholarship, £30 per annum, tenable for two years.

X. Ashbury Scholarships (Engineering), two, each of £25 per annum, tenable for two years.

Prizes.

I. Lee Greek Testament Prizes, one of £25 and one of £12 10s. value.

II. Classical Prizes.—Essay, value £5. Junior Class Prizes, value £5 and £2 10s.

III. Shuttleworth History Prize, value £5.

IV. English Essay and Poem Prizes, each of the value of £5.

V. Early English Text Society's Prizes.—A selection of the Society's publications offered to the competition of students in the Day and in the Evening Classes respectively.

VI. New Shakspeare Society's Book Prizes.

VII. Cobden Club Book Prizes (Political Economy).

VIII. Dalton Natural History Prize, value £15.

IX. Engineering Essay Prize, value £5.

UNIVERSITY COLLEGE, NOTTINGHAM.

Professor of Chemistry—Frank Clowes, D.Sc. Lond., F.I.C., F.C.S.

Demonstrator—Mr. J. B. Coleman, F.C.S.

Lecture Courses.—A systematic course of day lectures is delivered on Tuesday and Friday afternoons at 4.30: the non-metals are treated of in the Autumn Term (1st October to 15th December), the metals in the Spring Term (21st January to 7th April), and the carbon compounds in the Summer Term (21st April to 5th July).

A course of evening lectures runs parallel with the day course, being delivered on Wednesday evenings at 8 o'clock.

A lecture class in connection with both courses meets on Wednesday evenings at 7 o'clock.

Excursions are conducted by the Professor to works where the technical applications of chemistry may be seen by the students.

Students may qualify themselves by attendance at these lectures and classes for the Examinations of the Universities of London, Cambridge, or Oxford: they may also obtain instruction in Chemistry for technical or other purposes.

Fees.—For the day lectures, £2 10s. for the session, and one guinea for a term; for evening lectures, 2s. 6d. per term; or 5s. for lectures and classes.

Practical Chemistry.—The chemical laboratory is open every day except Saturday from 10 to 1 and from 2.30 to 5.30, also on Monday and Thursday evenings from 6.30 to 9.30. Each Student works independently of other Students at a course recommended by the Professor. Instruction is given in Chemical Analysis, and in Experimental and Applied Chemistry. A set of ordinary apparatus and reagents and a private locker are supplied free of charge, for the safe keeping of which the Student is held responsible; no extra charge is made for the use of gas and water, and of the cheaper chemicals.

Fees.—Inclusive fee £15 per session, or £6 6s. per term; terminal fee for day students for three hours weekly 20s., for six hours 35s., for nine hours 50s., and 10s. extra for each additional three hours per week; for evening students 10s. for one evening per week, and 18s. for two evenings per week.

Pharmaceutical Chemistry.—A course of lectures suited to Students for the Minor Examination of the Pharmaceutical Society is delivered during the Winter and Spring Terms at 8 on Tuesday evenings. Pharmaceutical Students are also admitted to the Chemical Laboratory three hours per week during term time.

Fees.—For lectures and laboratory, 10s. per term to members of the Nottingham Chemists' Association.

Students in the Government Classes.—Lectures and work under the direction of the demonstrator on Monday, Thursday, and Friday evenings.

All classes of Students are eligible to attend without distinction of sex. In virtue of the affiliation of the University College to Cambridge University a suitable course of study is recognised in lieu of part of the ordinary residence at Cambridge. For other information Students are referred to the College Calendar.

UNIVERSITY COLLEGE, DUNDEE.

Professor.—T. Carnelley, D.Sc., F.C.S.

Lecture Assistant.—John Foggie.

The first session of the College will be opened on an early day in October.

The Lectures and Laboratory practice in Chemistry are recognised by the Royal College of Physicians, London, and for degrees in Science and Medicine by the University of Edinburgh.

The courses are suitable for the Degrees of the London University and for the Civil Service appointments, and will also satisfy the requirements of students in Pharmacy, and of students who intend to become candidates for the Associateship of the Institute of Chemistry, so far as attendance at lectures on General and Theoretical Chemistry is concerned.

Lecture Courses.

The object of these courses will be (1) to give systematic instruction in the general principles of the science, and information regarding the elements and their more important compounds; (2) to show how this knowledge may be usefully applied in the Arts and Manufactures.

A course of instruction in Practical Chemistry in the Laboratory is recommended to all who wish to obtain a sound knowledge of the science, and the methods of applying it to useful purposes—the duration of such course depending upon the special wants of the student.—The Professor will be glad to give any information to intending students.

First year's lecture course: Tuesday, Thursday, and Saturday, from 9 to 10 a.m.; fee, £2 2s.

Second year's lecture course: Monday, Wednesday and Friday, from 9 to 10 a.m.; fee, £2 2s.

Practical Chemistry (Laboratory).

The aim of the Laboratory Courses is to make the student practically acquainted with the science, so that he may conduct chemical analysis and original research, and generally to fit him for applying the science to the Arts, Manufactures, and Agriculture. The courses are also suitable for students preparing for their medical and pharmaceutical examinations. A three months' course of Practical Chemistry for the B.Sc., Edinburgh, in the department of Public Health, may be taken in the College Laboratory.

The Laboratory will be open for students daily from 9 a.m. to 4 p.m., except on Saturdays, when it will be closed at 1 p.m. Each student on entering will be allowed to arrange his working hours to suit his own convenience, but will be required to keep the hours when once fixed.

Sessional Fees for Day Students.—The fees for both sessions are—for six hours per week, £3 3s.; each additional hour per week, 10s. 6d. Day students may not enter for less than six hours a week. Students joining the Laboratory during the second term will be charged two-thirds, and during the third term one-third of the above fees. Students may also enter for short periods, working every day in the week at the following fees:—For one month, £2 12s. 6d.; for two months, £5; for three months, £7 7s.

Evening Classes.—Courses of Lectures and Practical Laboratory instruction.

UNIVERSITY OF EDINBURGH.

Professor.—A. Crum Brown, F.R.S.E.

The Session will commence on October 23, 1883.

Two degrees in Science are conferred by the University of Edinburgh, viz., Bachelor of Science (B.Sc.) and Doctor of Science (D.Sc.). Both these degrees are conferred in Physical and Natural Science, in Public Health, and in Engineering.

Candidates for degrees in Physical and Natural Science must pass a preliminary examination in English, Latin, Arithmetic, the Elements of Mathematics, and the Elements of Mechanics, and in at least two of the following subjects:—Greek, French, German, Higher Mathematics, Natural Philosophy, Logic, and Moral Philosophy.

The First B.Sc. Examination embraces Mathematics, Natural Philosophy, Chemistry, Zoology, including Comparative Anatomy, and Botany. The Second B.Sc. Examination the Higher Higher Mathematics, Natural Philosophy, Experimental Physics, Chemistry, Zoology, Botany, Physiology, and Geology.

The D.Sc. Examination embraces Mathematics, Applied Mathematics, Experimental Physics, Practical Astronomy, Chemistry, Zoology and Comparative Anatomy, Animal Physiology, Botany, and Geology, including Palæontology and Mineralogy.

ANDERSON'S COLLEGE, GLASGOW.

Professor of Chemistry.—William Dittmar, F.R.S.E.

Chief Assistant.—John M'Arthur.

Laboratory Assistant.—James B. M'Arthur.

Junior Assistants.—Thomas Barbour, Robert Anderson, Archibald Kling.

A Course of 100 Experimental Lectures on Chemistry: Daily, Saturdays excepted, from 10.15 to 11.15, commencing on Wednesday, Oct. 31st. The Lectures up to the end of the year are devoted to the elements of Chemical Philosophy and to the Chemistry of the Non-metallic Elements. After the new year the Course divides into two branches, viz., the Chemistry of the Metals and Organic Chemistry, select chapters. Six written examinations are held during the Session, which all the members of the class are required to attend.

Fee, £2 2s.

The Laboratory is open daily (Saturdays excepted) during the Winter Session from 10 to 5, during Summer from 9.30 to 5. Advanced students may obtain permission to work privately on Saturdays also until 11 p.m. The teaching is conducted on the tutorial system, each student working by himself and on his own subject. The Laboratory is furnished with all the necessaries for chemical investigation.

Fee for the Winter Session, £10 10s.; Summer Session, £6 6s.; two sessions, if paid in advance, £15 15s., or £2 2s. per month.

Of the several duties which the prestige and traditions of this Chair impose upon its occupant, the first and foremost is to offer to young men, of even limited means, the opportunity of receiving a training in chemistry sufficient to prepare them fully for positions in chemical works, or as professional chemists.

A Special Practical Class for Medical Students, meeting twice a week during the Summer Session.

Evening Lectures, commencing on Friday, Sept. 28th, at 8 p.m.

THE

"YOUNG" CHAIR OF TECHNICAL CHEMISTRY,
ANDERSON'S COLLEGE.

Professor.—Edmund J. Mills, D.Sc. (Lond.), F.R.S.

Senior Assistant.—Mr. J. Snodgrass, F.C.S.

Junior Assistant.—Mr. J. Muter.

This Chair has for its object the instruction of Students in Chemistry as applied to the various branches of industry in Chemical and other works, Metallurgy, Agriculture, &c.

LECTURES.—*Principal Course.*—A Course of Twenty-five Lectures will be delivered on Mondays, Tuesdays, and Wednesdays, at 10 a.m., commencing on November 5th. The Lectures will be illustrated with Experiments, Diagrams, and Models, as well as by the actual Inspection of Manufacturing Processes; and the progress of the Students will be tested by periodical Examinations. These Lectures will have reference to units of weight and measure, to the calculations necessitated by Chemical operations, and to the nature and laws both of the Chemical process and its results, as illustrated in Chemical Technology.

Fee for the Course, One Guinea.

Subsidiary Course.—A subsequent Course of Thirty Lectures will be delivered on Mondays, Tuesdays, and Wednesdays, at 10 a.m. These Lectures are more particularly intended for Dyers, Colour Manufacturers, Brewers and Distillers, Tar Rectifiers, Drysalts, and others interested in a knowledge of Technical Organic Chemistry.

Fee for the Course, Two Guineas.

Evening Courses.—There will be special Evening course of twenty-five lectures on each of the following subjects, viz.:—Bleaching, Dyeing, and Printing, by Professor Mills; Iron and Steel Manufacture, and Fuel, by Mr. J. Snodgrass, senior assistant. These lectures will qualify for the May Examinations of the City and Guilds of London Institute. Practical classes in the same subjects will also be formed. For further particulars, see special Prospectuses.

Laboratories.—The Laboratories are open daily from 10 to 4, and on Saturday from 10 to 1 o'clock for practical working by the Students, under the superintendence of the Professor and his Assistants.

The Fee for attending the Laboratories is £20 per Session of Nine Months, £14 10s. for Six Months, £7 10s. for Three Months, or £2 10s. per month.

Students must have a fair acquaintance with elementary Chemistry.

The New Laboratory Buildings, immediately contiguous to the former site, are now erected and occupied. They comprise four stories, with a lecture room in the rear, and are exclusively devoted to the purposes of this Chair.

The Trustees, having had under consideration the requirements of Inventors, Patentees, and others whose investigations require isolation and privacy, as well as professional advice, have included in the arrangements Five Private Laboratories for Technical Research. Electric Cable has been laid to these laboratories for the supply, if required, of adequate power.

Library.—A Students' Library Society was founded in 1875. Its objects are to provide a collection of standard chemical works, and to maintain a regular supply of chemical journals. A large number of works have already been purchased or bestowed, and nine journals are received. Annual subscription, Half-a-crown.

Memorandum as to Bursaries.

The Trustees of the "Young" Chair have the superintendence of the Bursaries—regulating the appointment and terms on which they shall continue to be held.

The Nominees of Donors to be appointed if they pass the necessary examinations.

The Bursaries are of the amount of £50 each per annum, tenable for three years, during which the Bursars shall be required to give their whole time and attention to the Lectures and Laboratory duties of the "Young" Chair, paying the ordinary fees. Candidates to have attained sixteen years of age on application, to be of good moral character, and to pass such examinations as may be prescribed by the Trustees in the ordinary branches of an English education and the elementary principles of Chemistry. The Bursaries to be liable to forfeiture on the Bursars failing to exhibit approved progress under the Professor of the Chair, or being guilty of conduct, in the opinion of the Trustees, unworthy of their position. The

Bursaries are only given to those whose means are limited, and who intend following some branch of Manufacturing Chemistry.

QUEEN'S COLLEGE, BELFAST.

Professor.—E. A. Letts, Ph.D., F.R.S.E., F.C.S.
The Session begins October 16th.

I.—*Chemistry.*—The lectures are delivered at 3 p.m., on the first five days of each week until the beginning of April, and on two days of each week after May 1st. The course is divided into three parts:—(1) Chemical Philosophy; (2) Inorganic Chemistry; (3) Organic Chemistry.

II.—*Advanced and Organic Chemistry.*—Lectures on these subjects are given from the beginning of the Session, on Tuesdays and Thursdays, at 10 a.m., until the beginning of April, and on the same days at 3 p.m., after May 1st.

III.—*Practical Chemistry.*—In this course the Students are instructed in the general methods of conducting Chemical Analyses.

IV.—*Laboratory Pupils.*—The Chemical Laboratory is open from November until the beginning of April, and from May 1st until the middle of July, on the first five days of the week, from 10 a.m. until 4 p.m. The course of instruction is under the direction of the Professor of Chemistry, and of the Chemical Assistant. Students are admitted as working pupils on payment of a fee of £5 for the first period, or of £3 10s. for the second period (or for a single term).

QUEEN'S COLLEGE, CORK.

Professor.—Maxwell Simpson, D.Sc., M.D., F.R.S., &c.
The Session begins October 16th. The Chemistry Classes are held on Mondays, Wednesdays, and Fridays.
The Course is divided into Inorganic and Organic Chemistry.

In the first part are discussed the Laws of Combination and Affinity, Molecular Chemistry and Crystallography, and the History of the Non-Metallic and Metallic substances.

In the Organic portion of the Course will be considered the subjects of Organic Analysis, Organic Series, Compound Radicals and Types, Metamorphosis of Organic Bodies, History of Special Animal and Vegetable Bodies.

In treating of the Laws of Chemistry, and the History of Inorganic and Organic Bodies those points will be chiefly dwelt upon which have a practical bearing in the Arts, Medicine, Engineering, and Agriculture. Thence, during the Course, attention will be directed to the application of Chemistry to Medicine and Physiology, to Metallurgic Operations, Chemical Manufactures, Building Materials, Soils, and Manures.

Fee.—For each Sessional Course, £2. Each subsequent Course in Medicine, £1.

The Chemical Laboratory is open daily except on Saturdays, from 10 to 4 o'clock, under the Superintendence of the Professor, to Students desirous of prosecuting an extended course of qualitative and quantitative analysis, and for the purpose of original investigation in connection with the Arts, or in the higher departments of Scientific Chemistry.

UNIVERSITY OF DUBLIN. TRINITY COLLEGE.

Professor of Chemistry.—J. Emerson Reynolds, M.D., F.R.S.

Senior Assistant and Demonstrator.—William Early, F.I.C.

The professor of chemistry lectures on Elementary Chemistry during the whole of Michaelmas and Hilary Terms, on the Non-Metals and Metals; and the students repeat in the Laboratories many of the experiments shown at lecture.

The advanced course consists chiefly of Laboratory instruction in qualitative analysis (including spectrum

analysis) commencing in Michaelmas Term, about November 1st. Volumetric and gravimetric analysis, commencing in Hilary Term. Organic preparations and analysis, commencing in Trinity Term.

Professor Reynolds lectures on Organic Chemistry during Trinity Term. In the main Laboratory facilities are afforded for the prosecution of experimental researches.

ROYAL COLLEGE OF SCIENCE FOR IRELAND, STEPHEN'S GREEN, DUBLIN.

Professor of Practical and Theoretical Chemistry.—W. Noel Hartley, F.C.S.

The Session commences on Monday, October 1, 1883.

The Chemical and Metallurgical Laboratories, under the direction of Mr. Hartley, are open every week-day during the Session, except Saturday. Instruction is given in the different branches of Analytical Chemistry, including Assaying, and in the methods for performing Chemical Research. Fee, for the Session of nine months, £12; or for three months, £5; or for one month, £2.

There are four Royal Scholarships of the value of £50 each yearly, with Free Education, including Laboratory Instruction, tenable for two years; two become vacant each year; they are given to Students who have been a year in the College. There are also nine Exhibitions attached to the College, of the yearly value of £50 each, with Free Education, including Laboratory Instruction, tenable for three years; three become vacant each year.

A Diploma of Associate of the College is granted at the end of the three years' course.

Evening Classes.—Systematic Courses of Evening Lectures are given by most of the Professors throughout the Session.

CHEMICAL LECTURES, CLASSES, AND LABORATORY INSTRUCTION.

CITY AND GUILDS OF LONDON INSTITUTE FOR THE ADVANCEMENT OF TECHNICAL EDUCATION, Tabernacle Row, E.C.—Session commences October 4, 1883. Day and Evening Lectures and Laboratory instruction.

CITY OF LONDON COLLEGE, 52, Leadenhall Street, E.C.—Chemical Lecturer—Mr. J. Howard, F.C.S. The courses of lectures are as follows:—

Elementary Electricity Wednesdays, 8—9.
Elementary Chemistry Mondays, 7—8.

The Session will commence on Monday, October 1. Fee, 7s. 6d. per course.

These classes are specially arranged for Students preparing for the Science and Art Department Examinations, Matriculation, Chemists' Assistants, Teachers, &c.

CRYSTAL PALACE COMPANY'S SCHOOL OF ART, SCIENCE, AND LITERATURE. SCHOOL OF PRACTICAL ENGINEERING.

Principal.—Mr. J. W. Wilson, Memb. Inst. C.E.—This school was established with the purpose of affording to Students of Civil or of Mechanical Engineering the advantage of thorough practical instruction in the rudiments of either profession, and in the manipulation of materials. The leading object is to prepare Students, by systematic practical instruction, for professional articles, so that on entering an Engineer's office or works the pupil may at once be useful to his Principal, and enabled to take advantage of the opportunities for learning open to him, because he has mastered the elementary details of the profession. The school is also available for Students already articulated, who desire instruction in either the offices or shops. The Colonial Section is designed particularly for gentlemen who are going to the Colonies or abroad, as explorers or settlers. The object proposed is to afford them so much practical knowledge of scientific and mechanical work and expedients as shall enable them best

to utilise the means at their disposal, especially when entirely dependent on their own resources.

Ladies' Division.—The School was established to utilise the valuable Courts and Collections of the Crystal Palace for the purposes of instruction in Art, Science, Literature, &c., so that education of the highest class might be afforded under most advantageous conditions. The system of tuition is, for some subjects, in the manner of private tutorial instruction by the best masters, but other subjects are taught on the University method, in accordance with the regulations laid down by the Syndicate of the University of Cambridge, by whom some of the lectures and classes are conducted. A student may take lessons in one or several studies at option. The School is a centre for both the University of Oxford and the University of Cambridge Local Examinations, the Oxford Examination for Women, and for the Cambridge Higher Local Examination. The following examinations will be holden in the Ladies' Division during 1883-84:—Cambridge Local, December, 1883; Oxford Local and Oxford Examination for Women, June, 1884; Cambridge Higher Examination, June, 1884. The session opens on October 1.

CHARTERHOUSE INSTITUTION.—The Session commences September 22, under the presidency of the Rev. Henry Swann, M.A., Lectures and Practical Work in a well-fitted laboratory capable of holding 60 students.

BIRKBECK LITERARY AND SCIENTIFIC INSTITUTION, Southampton Buildings, Chancery Lane.—Inorganic Chemistry. Lectures:—Elementary, Tuesdays, 8.15 to 9.15; Advanced, Tuesdays, 9.15 to 10.15. Practice:—Elementary, Saturdays, 4 to 6; Advanced, Saturdays, 8 to 10. Teacher, Geo. Chaloner, F.C.S. Organic Chemistry:—Course of Thirty Lectures will be given on Tuesday evenings, at 7 o'clock, by Mr. H. Chapman Jones, F.C.S., commencing on October 2nd. Practical Chemistry:—This Class will meet in the Laboratory of the Institution, under the direction of Messrs. G. Chaloner and H. Chapman Jones, on Saturdays (Inorganic) from 4 to 6, and (Organic) from 8 to 10 p.m. A course of about thirty Lectures on the Manufacture of Iron and Steel, by Mr. G. Chaloner, on Saturdays at 7, commencing October 6.

BERNERS COLLEGE OF CHEMISTRY AND THE EXPERIMENTAL SCIENCES, 44, Berners Street, W.—Prof. E. V. Gardner, F.A.S., M.S.A. The Laboratory is open morning and evening throughout the year. A practical School of Science of a private character; the Courses of study are carried on by private class lectures in the various subjects, and by private Courses of study. These Courses are limited as to time, but are continued so long as is necessary to the Complete practical study of the subject or subjects by the Pupil or Pupils. The studies embrace the Experimental Sciences and Chemistry—Agricultural, Technical, and Analytical; the Science and Practice of Photography, Steam, Telegraphy, Electricity, Magnetism, and Galvanism, the Natural Sciences of Mineralogy, Geology, and Botany. The preparation of Gentlemen for the various Examining Boards and investigations connected with Patents are prominent features of the work of this College. Evening Classes.

NEW CENTRAL SCHOOL OF CHEMISTRY AND PHARMACY, 173, Marylebone Road, London.—Mr. A. P. Luff, F.I.C., F.C.S., and Mr. J. Woodland, F.C.S., M.P.S. In addition to the usual Chemical studies, Special Instruction Classes are held for Students of Medicine.

SOUTH LONDON SCHOOL OF CHEMISTRY, 325, Kennington Road.—Dr. John Muter, F.C.S. Daily, at 10 a.m. Lectures on Theoretical Chemistry, and Junior and Senior Course of Practical Chemistry.

ST. JOHN'S TRAINING COLLEGE, Battersea.—Both Theoretical and Practical Chemistry form part of the curriculum of the College. Lecturer and Director of the Laboratory, Alfred Senior, M.D., F.I.C., F.C.S.

THE WESTMINSTER COLLEGE OF CHEMISTRY AND PHARMACY, Trinity Square, S.E.—Messrs. Wills and Wootton. Daily, at 9 a.m. Theoretical and Practical Chemistry. Also Evening Classes, at 7.

CHEMICAL LECTURES AT LONDON HOSPITALS.

Chemical Schools and Colleges.	WINTER SESSION.				SUMMER SESSION.			
	Lecturers on Chemistry.	Days and Hours.	Fees.		Lecturers on Chemistry.	Days and Hours.	Fees.	
			One Course.	Perpetual.			One Course.	Perpetual.
St. Bartholomew's Hosp. and College	Dr. Russell, F.R.S.	M. W. F., 9	£ 6 16/6	9 9	Dr. Russell	M. Tu. F., 11 [to 1	£ 3 3	3 3
Charing Cross Hospital and College	Mr. Heaton	M. W. F., 4	5 5	8 18	Mr. Heaton	Daily at 10	4 4	4 4
St. George's Hospital	Mr. Donkin	Tu. Th. S., 11 1/2	7 7	7 7	Mr. Donkin	M. W. F., 10 to 1	7 7	7 7
Guy's Hospital	Dr. Debus, F.R.S., and Dr. Stevenson	Tu. Th. S., 11	7 7	7 7	Mr. Groves	M. W. Th., 10 1/2	6 6	8 8
King's College and Hosp.	Mr. Bloxam, F.C.S., Mr. Thomson, and Mr. Johnson	M. W. Th., 10 1/2	8 8	11 11	Mr. Bloxam and Mr. Thomson & Mr. Johnson	Daily at 9	5 5	4 4
London Hospital	Dr. Tidy	M. W. F., 10.30	7 7	10 10	Dr. Tidy	W. F. S., 9	4 4	4 4
St. Mary's Hospital	Dr. Wright	M. Th. 10, W. S., 9	6 16/6	8 8	Dr. Wright	M. W. F., 3	4 4	6 6
Middlesex Hospital	Mr. W. Foster	M. W. Th. Fr., 3	8 8	10 10	Mr. W. Foster	M. Th. F., 10	5 5	5 5
St. Thomas's Hosp. & Schl.	Dr. Bernays	Tu. Th. F., 10 1/2	7 7	7 7	Dr. Bernays	Dy. (ex. M. S.) 11	4 4	4 4
University Col. & Hosp.	Dr. Williamson, F.R.S.,	Daily (ex. S.), 11	7 7	9 9	Dr. Williamson	M. W. F., 10	5 5	5 5
Westminster Hospital ..	Dr. Dupré, F.R.S.	W. Th. F., 3	6 6	8 8	Dr. A. Dupré		4 4	4 4

SCHOOL OF PHARMACY OF THE PHARMACEUTICAL SOCIETY OF GREAT BRITAIN, 17, Bloomsbury Square.—The school opens on Monday, the 1st of October. Lectures on Chemistry and Pharmacy, by Professor Redwood, assisted by Mr. Wyndham R. Dunstan, F.C.S., on Monday, Tuesday, and Wednesday mornings, at 9 a.m. The Laboratories for Practical Instruction in Chemistry as applied to Pharmacy, &c., under the direction of Prof. Attfield, assisted by Mr. Wyndham R. Dunstan and Mr. F. W. Short, will be open daily at 10 a.m. throughout the Session. They are fitted up with every convenience for the study of the principles of Chemistry by personal experiment. They are specially designed for the student of Pharmacy, but are equally well adapted for the acquirement of a knowledge of Chemistry in its application to Medicine, Manufactures, Analysis, or Original Research. There is no general class

for simultaneous instruction, each student following an independent course of study always determined by his previous knowledge; pupils can therefore enter for any period at any date. Fees, One Course, £3 3s.; an entire Session—Two Courses, £4 4s.; Perpetual Admission, £5 5s. *Council Prizes.*—At the end of each of the five months' Courses of Lectures on Chemistry and Pharmacy, and Botany and Materia Medica, a Bronze Medal and Certificates of Merit, and at the close of the Session (ten months) a Silver Medal and Certificates of Honour and Merit, are offered for competition by the Council. In the Class of Practical Chemistry, a Silver Medal, two Bronze Medals, and Certificates of Honour and Merit, offered by the Council, are competed for at the end of the Session.

ONSLow COLLEGE OF SCIENCE, 183, Kings Road, Chelsea, S.W.—Lectures and Laboratory instruction in Chemistry and Pharmacy. Special Evening Classes in Inorganic and Organic Chemistry, &c. The Chemical and Metallurgical Laboratories are open every day and evening for practical work. Principal, Mr. W. H. Martin.

INSTITUTE OF AGRICULTURE, South Kensington.—Established for the purpose of advancing Technical Instruction upon various sections of Agricultural Practice, as a preparation for learning the business of farming, and especially for bringing these advantages within the reach of any and every person who may wish to avoid the expenses which are at present associated with education of this character. In the Lecture Theatre of the Museum of Geology, Jermyn-street, London: A course of forty lectures upon Chemistry in relation to the Soil, by Bernard Dyer, F.C.S., F.I.C., commencing Oct. 1st. In the Lecture Theatre of South Kensington Museum: A course of ten lectures upon the Chemistry of the Food of Farm Stock, by Professor R. V. Tuson, F.I.C., commencing Jan. 21st, 1884.

BIRMINGHAM.—QUEEN'S COLLEGE.—In connection with this College the Chemistry Lectures are given at Mason Science College, by Prof. W. A. Tilden.

BRISTOL MEDICAL SCHOOL.—Mr. T. Coomber, F.C.S.

INSTITUTE OF CHEMICAL TECHNOLOGY, Hackins Hey, Liverpool.—Principal, Mr. A. Norman Tate, F.I.C. The course of instruction is intended more especially for students who wish to gain a knowledge of chemistry and the allied sciences in their relation to industrial and commercial pursuits, and embraces a thorough preliminary course of theoretical chemistry and practical laboratory work, followed by instruction in chemical technology fitted to the requirements of each pupil. In addition to these chemical studies, students who desire it can enter upon a special course calculated to afford them knowledge useful in the erection and arrangement of manufactories and plant, and construction of apparatus. Fee: Fifty guineas per annum, with extra fee according to circumstances for the special course.

LEEDS SCHOOL OF MEDICINE.—Prof. T. E. Thorpe, Ph.D., F.R.S.

QUEENWOOD COLLEGE, near Stockbridge, Hants.—Dr. H. Wilson Hake, F.C.S., F.I.C. Lectures on Inorganic Chemistry and Physics and Laboratory Instruction. Principal, Mr. C. Willmore.

SALFORD WORKING MEN'S COLLEGE, EVENING CLASSES.—Teacher of Chemistry, Mr. G. H. Hurst. Lectures on Organic and Inorganic Chemistry and practical laboratory instruction.

SHEFFIELD SCHOOL OF MEDICINE.—Mr. A. H. Allen, F.C.S.

SHEFFIELD BOROUGH ANALYSTS' LABORATORY, 1, Surrey Street.—Mr. A. H. Allen, F.C.S. Day and Evening Classes.

WESLEY COLLEGE, SHEFFIELD.—Lectures on Physics, by Mr. A. H. Allen, F.C.S.; Chemistry, with daily demonstrations and laboratory practice, by Mr. R. W. Lancaster; Biology, with lectures and laboratory practice, by the Principal, the Rev. W. H. Dallinger, F.R.S., commencing September 20.

UNIVERSITY OF ABERDEEN.—Mr. J. S. Brazier, F.C.S.

DUNDEE LITERARY INSTITUTION CHEMICAL AND PHYSICAL LABORATORY.—Lecturers on Chemistry, Mr. Frank W. Young, F.C.S., and Mr. John Thomson. Classes and Evening Lectures daily.

SCHOOL OF MEDICINE, SURGEON'S HALL, EDINBURGH.—Dr. Stevenson Macadam, F.R.S.E., Mr. Falconer King, Mr. Ivison Macadam, Mr. Drinkwater, and Mr. Buchanan.

SCHOOL OF PHARMACY AND CHEMISTRY, EDINBURGH.—The instruction qualifies for graduation in Medicine and Science in the University of Edinburgh and other Examining Boards. Day and Evening Classes.

EDINBURGH SCHOOL OF MEDICINE, 41, Chambers St.—The instruction here qualifies for all Medical Boards, Edinburgh University, London University, &c. Day and Evening Classes.

MINTO HOUSE MEDICAL SCHOOL, CHAMBERS STREET, EDINBURGH.—Mr. J. Falconer King, F.I.C., F.C.S. Lectures and Classes.

NEW VETERINARY COLLEGE, GAYFIELD HOUSE, EDINBURGH.—Dr. Stevenson Macadam and Mr. Falconer King, F.C.S.

SCIENCE SCHOOLS, FALKIRK.—Andrew Wilson and Assistants. Day and Evening Classes in Theoretical and Practical Chemistry.

GLASGOW UNIVERSITY.—Prof. J. Ferguson.

GLASGOW VETERINARY COLLEGE.—Professor Cooke, F.C.S.

COLLEGE OF SCIENCE AND ARTS, GLASGOW.—Mr. R. R. Tatlock, F.C.S., and Dr. Clark, F.C.S. Day and Evening Classes.

SCHOOL OF CHEMISTRY, 138, Bath Street, Glasgow.—Dr. Wallace, Mr. Tatlock, and Dr. Clark. Day and Evening Classes.

CHEMICAL LABORATORY, 180, West Regent Street, Glasgow.—Dr. Milne. Day and Evening Classes.

QUEEN'S COLLEGE, GALWAY.—Dr. T. H. Rowney.

MUNSTER AGRICULTURAL AND DAIRY SCHOOL.—Thomas Farrington, M.A., F.C.S.

ROYAL COLLEGE OF SURGEONS IN IRELAND.—Dr. C. A. Cameron, F.I.C. The Laboratories of the College are provided with every appliance for the study of Chemistry, especially in its application to Medicine, Hygiene, and Pharmacy.

DUBLIN, CARMICHAEL COLLEGE OF MEDICINE.—Dr. C. R. C. Tichborne.

DUBLIN, CATHOLIC UNIVERSITY.—Dr. Campbell.

DUBLIN, DR. STEEVENS'S HOSPITAL AND MEDICAL COLLEGE.—Mr. McHugh.

MECHANICS' INSTITUTE, Abbey Street, Dublin.—Mr. Clement J. Leaper.

Detection of Traces of Bismuth.—J. C. Tresh.—If potassium iodide is added to a small quantity of a free acid,—hydrochloric or an organic acid,—there appears in presence of bismuth a more or less intense orange colour. If the metal is 1-10,000th, the colour is a decided orange; if 1-40,000th, a pale orange; and 1-1,000,000th, yellow. Lead and mercury do not interfere.—*Zeitschrift für Analytische Chemie.*

THE YORKSHIRE COLLEGE, LEEDS.

The Tenth Session begins on the 2nd October.

Chemistry: Prof. THORPE, Ph.D., F.R.S., F.C.S.
Dyeing: Instructor J. HUMMEL, F.C.S.

Lectures and Practical Work in Laboratories and Dyehouse. Classes in the Science, Literature, and Technological Departments prepare for University, and other examinations, and for various professions.

Prospectus of any Department may be had free on application to the Secretary.

NORMAL SCHOOL OF SCIENCE AND ROYAL SCHOOL OF MINES, South Kensington.

Dean, Professor HUXLEY, P.R.S.

SESSION 1883-4.

BIOLOGY—Professor Huxley will begin a course of lectures on 1st October.

CHEMISTRY—Professor Frankland will begin a course of lectures on 1st October.

PHYSICS—Professor Guthrie will begin a course of lectures on 3rd October.

METALLURGY—Professor Chandler Roberts will begin a course of lectures on 1st October.

AGRICULTURE—Mr. Wrightson will begin a course of lectures on 1st October.

Further particulars may be obtained from the Registrar.

CITY AND GUILDS OF LONDON INSTITUTE. TECHNICAL COLLEGE, FINSBURY.

EVENING DEPARTMENT for Apprentices, Journeymen, Foremen, and others. Instruction in Mechanical and Electrical Engineering, Technical Chemistry, Applied Art, Cabinet-making, Metal Plate Work, Plumbers' Work, Carpentry, Joinery, Bricklaying, &c. Fees, from 7s. to 30s. for the Session, inclusive of laboratories and workshops.

The NEW SESSION COMMENCES on October 4, 1883.

For programme of instruction apply at the College, Tabernacle Row, E.C.; or at the Offices of the Institute, Gresham College, E.C.

CITY AND GUILDS OF LONDON INSTITUTE.

TECHNOLOGICAL EXAMINATIONS.—

The next Examination will be held on May 28th, 1884. Teachers desiring to form classes should apply at once to the Director, at the Office of the Institute, Gresham College, London, E.C. The programme for 1883-4 is now ready.

PHILIP MAGNUS, Director and Secretary.

THE LONDON HOSPITAL and MEDICAL

COLLEGE, MILE END, E.—The SESSION 1883-4 will commence on Monday, October 1st, 1883. The Prizes for the past Session, and the Nursing Probationers' Prizes, will be distributed on Tuesday, October 9th, at 8 p.m., by Professor Huxley, P.R.S., who will also make an Address, after which there will be a Conversation, to which all past and present students are invited. **FOUR ENTRANCE SCHOLARSHIPS**, value £60, £40, £30, and £20, will be offered for competition at the end of September to new Students. Fees for Lectures and Hospital Practice, 90 guineas in one payment, or 100 guineas in three instalments. All resident and other Hospital appointments are free. The resident appointments consist of Five House Physicians, Five House Surgeons, and One Accoucheurship; Two Dressers and Two Maternity Pupils also reside in the Hospital. Special entries may be made for Medical and Surgical Practice. The London Hospital is now in direct communication by rail and tram with all parts of the metropolis.

MUNRO SCOTT, Warden.

UNIVERSITY COLLEGE, DUNDEE.

The FIRST SESSION will begin on MONDAY, 8th OCTOBER. CLASSES will meet in the following Departments:—

Mathematics and Natural Philosophy	Prof. J. E. A. STEGGALL, M.A. Demonstrator—J. W. CAP- STICK, B.A., B.Sc.
Chemistry	Prof. THOMAS CARNELLEY, D.Sc., B.Sc., F.C.S.
Engineering and Drawing ..	Prof. J. A. EWING, B.Sc., F.R.S.E.
Classics and Ancient History ..	Prof. W. PETERSON, M.A.
English Language and Literature and Modern History	Prof. THOMAS GILRAY, M.A., F.R.S.E.

The PHYSICAL, CHEMICAL, ENGINEERING, and ELECTRICAL ENGINEERING LABORATORIES are furnished with every appliance for study and research.

There are DAY and EVENING CLASSES, all of which are open to Women.

The various Courses are suitable for the Degree Examinations of the University of London, and for the Examination for the L.L.A. Certificate in St. Andrews University.

The Examination for the SMART BURSARY in ENGINEERING will be held on the 3rd and 4th October.

For further information see the College Calendar.

SHIELL and SMALL, Secretaries.

LIVERPOOL COLLEGE OF CHEMISTRY, DUKE STREET.

PRINCIPAL—GEORGE TATE, Ph.D., F.G.S., F.C.S.

Prospectuses of the Courses may be had on application.

ROYAL COLLEGE OF SCIENCE FOR IRELAND,

STEPHEN'S GREEN, DUBLIN.

SCIENTIFIC AND TECHNICAL EDUCATION.
SESSION 1883-84.

This College supplies a complete course of Instruction in Science as applied to the Industrial Arts, especially those which may be classed broadly under the heads of CHEMICAL MANUFACTURES, MINING, and ENGINEERING.

A Diploma of Associate of the College is granted at the end of the Three Years' Course.

There are Four Royal Scholarships, tenable for two years, each of the value of £50 yearly, with free education, including Laboratory Instruction. Two become vacant each year. They are given to Students who have been a year in the College.

The Fees are £2 for each Course, or £10 for all the Courses of each year, with the exception of Laboratory Practice.

Chemistry (Theoretical and Prac- tical), Metallurgy, &c.	Professor HARTLEY, F.C.S., F.R.S.E.
Mathematics, Mechanics, and Mechanism	Professor HENNESSY, F.R.S., M.R.I.A.
Descriptive Geometry, Drawing, Engineering, and Surveying. . .	Professor PIGOT, C.E., M.R.I.A., Dean of Faculty.
Experimental Physics (Theoreti- cal and Practical)	Professor BARRETT, F.R.S.E., M.R.I.A.
Mining and Mineralogy	Prof. O'REILLY, C.E., M.R.I.A.
Botany	Professor M'NAB, M.D., F.L.S.
Zoology	Professor HADDON, M.A., F.Z.S.
Geology	Prof. HULL, M.A., LL.D., F.R.S.
Palæontology	Mr. BAILY, F.L.S., F.G.S., M.R.I.A.

The Chemical and Physical Laboratories and Drawing School are open daily for Practical Instruction.

Fee for Chemical Laboratory, £2 for One month, £5 for Three months, £9 for Six months, or £12 for Session. Fee for Physical Laboratory, £1 per month, or £6 for Session. Fee for Special Course of applied Electricity and Laboratory, £4. Fee for Biological Laboratory, £2 for the term. Fee for Drawing School, £3 for Session, or £2 for one term.

The SESSION COMMENCES on MONDAY, OCTOBER 1st.

Programmes may be obtained on application at the College, or by letter addressed to the Secretary, Royal College of Science, Stephen's Green, Dublin.

Professor J. P. O'REILLY, Secretary, *pro tem*.

INSTITUTE OF CHEMICAL TECHNOLOGY AND ANALYTICAL LABORATORY,

5, 9, and 11, PHILADELPHIA CHAMBERS, HACKINS HEY,
and 3 and 12A, ASHTON CHAMBERS, HACKINS HEY,
LIVERPOOL.

PRINCIPAL—A. NORMAN TATE, F.I.C.

Designed for the examination, for scientific, commercial, and industrial purposes, of substances used and produced in the Arts and Manufactures, and found in Commerce; and for the instruction of Students in Chemistry and the allied sciences in their relation to industrial and commercial pursuits.

The Laboratories have lately been entirely re-arranged and considerably extended, and are provided with all appliances necessary for analytical investigations, special technical examinations, and Student's work.

Students' fees, fifty guineas per annum.

In addition to their chemical studies, Students who desire it can enter upon a course of instruction calculated to afford them knowledge useful in the erection and arrangement of manufacturing buildings and plant, and construction of apparatus. Special fees are charged for this course.

All communications should be addressed to Mr. A. NORMAN TATE, 9, Hackins Hey, Liverpool, as, owing to similarity of surname with that of the principal of another chemical establishment in Liverpool, misconception and mistakes have arisen.

UNIVERSITY COLLEGE, BRISTOL. CHEMICAL DEPARTMENT.

Professor—W. RAMSAY, Ph.D. Lecturer—SYDNEY YOUNG, D.Sc

The SESSION 1883-84 begins on 8th OCTOBER. Lectures on Inorganic, Organic, and Technical Chemistry will be delivered during the Session. The Laboratories are fitted with the most recent improvements for the study of Practical Chemistry in all its branches. In the evening, Lectures on Inorganic Chemistry at reduced fees are delivered; and a special Course of Lectures on Technical Chemistry is also given, with the co-operation of the Worshipful Company of Clothworkers. Several Scholarships are tenable at the College.

Calendar, containing full information, price 6d., by post 8d. For prospectus and further information apply to

ALFRED E. STOCK, Registrar and Secretary,

THE CHEMICAL NEWS.

VOL. XLVIII. No. 1243.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

SOUTHPORT MEETING, SEPTEMBER 19, 1883.

INAUGURAL ADDRESS OF THE PRESIDENT,

ARTHUR CAYLEY, M.A., D.C.L., LL.D., F.R.S.,
Sadlerian Professor of Pure Mathematics in the
University of Cambridge.

SINCE our last meeting we have been deprived of three of our most distinguished members. The loss by the death of Professor Henry John Stephen Smith is a very grievous one to those who knew and admired and loved him, to his University, and to mathematical science, which he cultivated with such ardour and success. I need hardly recall that the branch of mathematics to which he had specially devoted himself was that most interesting and difficult one, the Theory of Numbers. The immense range of this subject, connected with and ramifying into so many others, is nowhere so well seen as in the series of reports on the progress thereof, brought up unfortunately only to the year 1865, contributed by him to the Reports of the Association; but it will still better appear when to these are united (as will be done in the collected works in course of publication by the Clarendon Press) his other mathematical writings, many of them containing his own further developments of theories referred to in the reports. There have been recently or are being published many such collected editions—Abel, Cauchy, Clifford, Gauss, Green, Jacobi, Lagrange, Maxwell, Riemann, Steiner. Among these the works of Henry Smith will occupy a worthy position.

More recently, General Sir Edward Sabine, K.C.B., for twenty-one years general secretary of the Association, and a trustee, President of the meeting at Belfast in the year 1852, and for many years treasurer and afterwards President of the Royal Society, has been taken from us, at an age exceeding the ordinary age of man. Born October, 1788, he entered the Royal Artillery in 1803, and commanded batteries at the siege of Fort Erie in 1814; made magnetic and other observations in Ross and Parry's North Polar exploration in 1818-19, and in a series of other voyages. He contributed to the Association reports on Magnetic Forces in 1836-7-8, and about forty papers to the *Philosophical Transactions*; originated the system of Magnetic Observatories, and otherwise signally promoted the science of Terrestrial Magnetism.

There is yet a very great loss: another late President and trustee of the Association, one who has done for it so much, and has so often attended the meetings, whose presence among us at this meeting we might have hoped for—the President of the Royal Society, William Spottiswoode. It is unnecessary to say anything of his various merits: the place of his burial, the crowd of sorrowing friends who were present in the Abbey, bear witness to the esteem in which he was held.

I take the opportunity of mentioning the completion of a work promoted by the Association: the determination by Mr. James Glaisher of the least factors of the missing three out of the first nine million numbers: the volume containing the sixth million is now published.

I wish to speak to you to-night upon Mathematics. I am quite aware of the difficulty arising from the abstract

nature of my subject; and if, as I fear, many or some of you, recalling the Presidential Addresses at former meetings—for instance, the *résumé* and survey which we had at York of the progress, during the half-century of the lifetime of the Association, of a whole circle of sciences—Biology, Palæontology, Geology, Astronomy, Chemistry—so much more familiar to you, and in which there was so much to tell of the fairy-tales of science; or at Southampton, the discourse of my friend who has in such kind terms introduced me to you, on the wondrous practical applications of science to electric lighting, telegraphy, the St. Gothard Tunnel and the Suez Canal, gun-cotton, and a host of other purposes, and with the grand concluding speculation on the conservation of solar energy: if, I say, recalling these or any earlier Addresses, you should wish that you were now about to have, from a different President, a discourse on a different subject, I can very well sympathise with you in the feeling.

But be this as it may, I think it is more respectful to you that I should speak to you upon and do my best to interest you in the subject which has occupied me, and in which I am myself most interested. And in another point of view, I think it is right that the Address of a President should be on his own subject, and that different subjects should be thus brought in turn before the meetings. So much the worse, it may be, for a particular meeting; but the meeting is the individual, which on evolution principles must be sacrificed for the development of the race.

Mathematics connect themselves on the one side with common life and the physical sciences; on the other side with philosophy, in regard to our notions of space and time, and in the questions which have arisen as to the universality and necessity of the truths of mathematics, and the foundation of our knowledge of them. I would remark here that the connection (if it exists) of arithmetic and algebra with the notion of time is far less obvious than that of geometry with the notion of space.

As to the former side, I am not making before you a defence of mathematics, but if I were I should desire to do it—in such manner as in the "Republic" Socrates was required to defend justice, quite irrespectively of the worldly advantages which may accompany a life of virtue and justice, and to show that, independently of all these, justice was a thing desirable in itself and for its own sake—not by speaking to you of the utility of mathematics in any of the questions of common life or of physical science. Still less would I speak of this utility before, I trust, a friendly audience, interested or willing to appreciate an interest in mathematics in itself and for its own sake. I would, on the contrary, rather consider the obligations of mathematics to these different subjects as the sources of mathematical theories now as remote from them, and in as different a region of thought—for instance, geometry from the measurement of land, or the Theory of Numbers from arithmetic—as a river at its mouth is from its mountain source.

On the other side, the general opinion has been and is that it is indeed by experience that we arrive at the truths of mathematics, but that experience is not their proper foundation: the mind itself contributes something. This is involved in the Platonic theory of reminiscence; looking at two things, trees or stones or anything else, which seem to us more or less equal, we arrive at the idea of equality: but we must have had this idea of equality before the time when first seeing the two things we were led to regard them as coming up more or less perfectly to this idea of equality; and the like as regards our idea of the beautiful, and in other cases.

The same view is expressed in the answer of Leibnitz, the *nisi intellectus ipse*, to the scholastic dictum, *nihil in intellectu quod non prius in sensu*: there is nothing in the intellect which was not first in sensation, except (said Leibnitz) the intellect itself. And so again in the "Critick of Pure Reason," Kant's view is that while there is no doubt but that all our cognition begins with experience,

we are nevertheless in possession of cognitions *a priori*, independent, not of this or that experience, but absolutely so of all experience, and in particular that the axioms of mathematics furnish an example of such cognitions *a priori*. Kant holds further that space is no empirical conception which has been derived from external experiences, but that in order that sensations may be referred to something external, the representation of space must already lie at the foundation; and that the external experience is itself first only possible by this representation of space. And in like manner time is no empirical conception which can be deduced from an experience, but it is a necessary representation lying at the foundation of all intuitions.

And so in regard to mathematics, Sir W. R. Hamilton, in an Introductory Lecture on astronomy (1836), observes: "These purely mathematical sciences of algebra and geometry are sciences of the pure reason, deriving no weight and no assistance from experiment, and isolated or at least isolable from all outward and accidental phenomena. The idea of order with its subordinate ideas of number and figure, we must not indeed call innate ideas, if that phrase be defined to imply that all men must possess them with equal clearness and fulness: they are, however, ideas which seem to be so far born with us that the possession of them in any conceivable degree is only the development of our original powers, the unfolding of our proper humanity."

The general question of the ideas of space and time, the axioms and definitions of geometry, the axioms relating to number, and the nature of mathematical reasoning, are fully and ably discussed in Whewell's "Philosophy of the Inductive Sciences" (1840), which may be regarded as containing an exposition of the whole theory.

But it is maintained by John Stuart Mill that the truths of mathematics, in particular those of geometry, rest on experience; and as regards geometry, the same view is on very different grounds maintained by the mathematician Riemann.

It is not so easy as at first sight it appears to make out how far the views taken by Mill in his "System of Logic Ratiocinative and Inductive" (9th ed., 1879), are absolutely contradictory to those which have been spoken of; they profess to be so; there are most definite assertions (supported by argument), for instance, p. 263:—"It remains to enquire what is the ground of our belief in axioms, what is the evidence on which they rest. I answer, they are experimental truths, generalisations from experience. The proposition, 'Two straight lines cannot enclose a space,' or, in other words, two straight lines which have once met cannot meet again, is an induction from the evidence of our senses." But I cannot help considering a previous argument (p. 259) as very materially modifying this absolute contradiction. After enquiring "Why are mathematics by almost all philosophers . . . considered to be independent of the evidence of experience and observation, and characterised as systems of necessary truth?" Mill proceeds (I quote the whole passage) as follows:—"The answer I conceive to be that this character of necessity ascribed to the truths of mathematics, and even (with some reservations to be hereafter made) the peculiar certainty ascribed to them, is a delusion, in order to sustain which it is necessary to suppose that those truths relate to and express the properties of purely imaginary objects. It is acknowledged that the conclusions of geometry are derived partly at least from the so-called definitions, and that these definitions are assumed to be correct representations, as far as they go, of the objects with which geometry is conversant. Now we have pointed out that from a definition as such no proposition unless it be one concerning the meaning of a word can ever follow, and that what apparently follows from a definition follows in reality from an implied assumption that there exists a real thing conformable thereto. This assumption in the case of the definitions of geometry is not strictly true: there exist no real things

exactly conformable to the definitions. There exist no real points without magnitude, no lines without breadth, nor perfectly straight, no circles with all their radii exactly equal, nor squares with all their angles perfectly right. It will be said that the assumption does not extend to the actual but only to the possible existence of such things. I answer that according to every test we have of possibility they are not even possible. Their existence, so far as we can form any judgment, would seem to be inconsistent with the physical constitution of our planet at least, if not of the universal [*sic*]. To get rid of this difficulty and at the same time to save the credit of the supposed system of necessary truth, it is customary to say that the points, lines, circles, and squares which are the subjects of geometry exist in our conceptions merely and are parts of our minds; which minds by working on their own materials construct an *a priori* science, the evidence of which is purely mental and has nothing to do with outward experience. By howsoever high authority this doctrine has been sanctioned, it appears to me psychologically incorrect. The points, lines, and squares which anyone has in his mind are (as I apprehend) simply copies of the points, lines, and squares which he has known in his experience. Our idea of a point I apprehend to be simply our idea of the *minimum visibile*, the small portion of surface which we can see. We can reason about a line as if it had no breadth, because we have a power which we can exercise over the operations of our minds: the power, when a perception is present to our senses or a conception to our intellects, of attending to a part only of that perception or conception instead of the whole. But we cannot conceive a line without breadth: we can form no mental picture of such a line; all the lines which we have in our mind are lines possessing breadth. If anyone doubt this, we may refer him to his own experience. I much question if anyone who fancies that he can conceive of a mathematical line thinks so from the evidence of his own consciousness. I suspect it is rather because he supposes that unless such a perception be possible, mathematics could not exist as a science: a supposition which there will be no difficulty in showing to be groundless."

I think it may be at once conceded that the truths of geometry are truths precisely because they relate to and express the properties of what Mill calls "purely imaginary objects;" that these objects do not exist in Mill's sense, that they do not exist in nature, may also be granted; that they are "not even possible," if this means not possible in an existing nature, may also be granted. That we cannot "conceive" them depends on the meaning which we attach to the word conceive. I would myself say that the purely imaginary objects are the only realities, the *ὄντως ὄντα*, in regard to which the corresponding physical objects are as the shadows in the cave; and it is only by means of them that we are able to deny the existence of a corresponding physical object; if there is no conception of straightness, then it is meaningless to deny the existence of a perfectly straight line.

But at any rate the rate the objects of geometrical truth are the so-called imaginary objects of Mill, and the truths of geometry are only true, and *a fortiori* are only necessarily true, in regard to these so-called imaginary objects; and these objects, points, lines, circles, &c., in the mathematical sense of the terms, have a likeness to and are represented more or less imperfectly, and from a geometer's point of view no matter how imperfectly, by corresponding physical points, lines, circles, &c. I shall have to return to geometry, and will then speak of Riemann, but I will first refer to another passage of the Logic.

Speaking of the truths of arithmetic Mill says (p. 297) that even here there is one hypothetical element: "In all propositions concerning numbers a condition is implied without which none of them would be true, and that condition is an assumption which may be false. The condition is that $1=1$: that all the numbers are numbers of the same or of equal units." Here at least the assumption

may be absolutely true; one shilling = one shilling in purchasing power, although they may not be absolutely of the same weight and fineness: but it is hardly necessary; one coin + one coin = two coins, even if the one be a shilling and the other a half crown. In fact, whatever difficulty be raisable as to geometry, it seems to me that no similar difficulty applies to arithmetic; mathematician or not, we have each of us, in its most abstract form, the idea of a number; we can each of us appreciate the truth of a proposition in regard to numbers; and we cannot but see that a truth in regard to numbers is something different in kind from an experimental truth generalised from experience. Compare, for instance, the proposition that the sun, having already risen so many times, will rise tomorrow, and the next day, and the day after that, and so on; and the proposition that even and odd numbers succeed each other alternately *ad infinitum*: the latter at least seems to have the characters of universality and necessity. Or again, suppose a proposition observed to hold good for a long series of numbers, one thousand numbers, two thousand numbers, as the case may be; this is not only no proof, but it is absolutely no evidence, that the proposition is a true proposition, holding good for all numbers whatever; there are in the Theory of Numbers very remarkable instances of propositions observed to hold good for very long series of numbers and which are nevertheless untrue.

I pass in review certain mathematical theories.

In arithmetic and algebra, or say in analysis, the numbers or magnitudes which we represent by symbols are in the first instance ordinary (that is, positive) numbers or magnitudes. We have also in analysis and in analytical geometry *negative* magnitudes; there has been in regard to these plenty of philosophical discussion, and I might refer to Kant's paper, "Ueber die negativen Grössen in die Weltweisheit" (1763), but the notion of a negative magnitude has become quite a familiar one, and has extended itself into common phraseology. I may remark that it is used in a very refined manner in bookkeeping by double entry.

But it is far otherwise with the notion which is really the fundamental one (and I cannot too strongly emphasise the assertion) underlying and pervading the whole of modern analysis and geometry, that of imaginary magnitude in analysis and of imaginary space (or space as a *locus in quo* of imaginary points and figures) in geometry: I use in each case the word imaginary as including real. This has not been, so far as I am aware, a subject of philosophical discussion or enquiry. As regards the older metaphysical writers this would be quite accounted for by saying that they knew nothing, and were not bound to know anything about it; but at present, and, considering the prominent position which the notion occupies—say even that the conclusion were that the notion belongs to mere technical mathematics, or has reference to nonentities in regard to which no science is possible, still it seems to me that (as a subject of philosophical discussion) the notion ought not to be thus ignored; it should at least be shown that there is a right to ignore it.

Although in logical order I should perhaps now speak of the notion just referred to, it will be convenient to speak first of some other quasi-geometrical notions; those of more-than-three-dimensional space, and of non-Euclidian two- and three-dimensional space, and also of the generalised notion of distance. It is in connection with these that Riemann considered that our notion of space is founded on experience, or rather that it is only by experience that we know that our space is Euclidian space.

It is well known that Euclid's twelfth axiom, even in Playfair's form of it, has been considered as needing demonstration; and that Lobatschewsky constructed a perfectly consistent theory, wherein this axiom was assumed not to hold good, or say a system of non-Euclidian plane geometry. There is a like system of non-Euclidian solid

geometry. My own view is that Euclid's twelfth axiom in Playfair's form of it does not need demonstration, but is part of our notion of space, of the physical space of our experience—the space, that is, which we become acquainted with by experience, but which is the representation lying at the foundation of all external experience. Riemann's view before referred to may I think be said to be that, having *in intellectu* a more general notion of space (in fact a notion of non-Euclidian space), we learn by experience that space (the physical space of our experience) is, if not exactly, at least to the highest degree of approximation, Euclidian space.

But suppose the physical space of our experience to be thus only approximately Euclidian space, what is the consequence which follows? Not that the propositions of geometry are only approximately true, but that they remain absolutely true in regard to that Euclidian space which has been so long regarded as being the physical space of our experience.

It is interesting to consider to different ways in which, without any modification at all of our notion of space, we can arrive at a system of non-Euclidian (plane or two-dimensional) geometry; and the doing so, will, I think, throw some light on the whole question.

First, imagine the earth a perfectly smooth sphere; understand by a plane the surface of the earth, and by a line the apparently straight line (in fact an arc of great circle) drawn on the surface; what experience would in the first instance teach would be Euclidian geometry; there would be intersecting lines which produced a few miles or so would seem to go on diverging: and apparently parallel lines which would exhibit no tendency to approach each other; and the inhabitants might very well conceive that they had by experience established the axiom that two straight lines cannot enclose a space, and the axiom as to parallel lines. A more extended experience and more accurate measurements would teach them that the axioms were each of them false; and that any two lines, if produced far enough each way, would meet in two points: they would in fact arrive at a spherical geometry, accurately representing the properties of the two-dimensional space of their experience. But their original Euclidian geometry would not the less be a true system: only it would apply to an ideal space, not the space of their experience.

Secondly, consider an ordinary, indefinitely extended plane; and let us modify only the notion of distance. We measure distance, say, by a yard measure or a foot rule, anything which is short enough to make the fractions of it of no consequence (in mathematical language by an infinitesimal element of length); imagine, then, the length of this rule constantly changing (as it might do by an alteration of temperature), but under the condition that its actual length shall depend only on its situation on the plane and on its direction: viz., if for a given situation and direction it has a certain length, then whenever it comes back to the same situation and direction it must have the same length. The distance along a given straight or curved line between any two points could then be measured in the ordinary manner with this rule, and would have a perfectly determinate value: it could be measured over and over again, and would always be the same; but of course it would be the distance, not in the ordinary acceptance of the term, but in quite a different acceptance. Or in somewhat different way: if the rate of progress from a given point in a given direction be conceived as depending only on the configuration of the ground, and the distance along a given path between any two points thereof be measured by the time required by traversing it, then in this way also the distance would have a perfectly determinate value; but it would be a distance, not in the ordinary acceptance of the term, but in quite a different acceptance. And corresponding to the new notion of distance we should have a new, non-Euclidian system of plane geometry; all theorems involving the notion of distance would be altered.

We may proceed further. Suppose that as the rule moves away from a fixed central point of the plane it becomes shorter and shorter; if this shortening takes place with sufficient rapidity, it may very well be that a distance which in the ordinary sense of the word is finite will in the new sense be infinite; no number of repetitions of the length of the ever-shortening rule will be sufficient to cover it. There will be surrounding the central point a certain finite area such that (in the new acceptation of the term distance) each point of the boundary thereof will be at an infinite distance from the central point; the points outside this area you cannot by any means arrive at with your rule; they will form a *terra incognita*, or rather an unknowable land: in mathematical language, an imaginary or impossible space: and the plane space of the theory will be that within the finite area—that is, it will be finite instead of infinite.

We thus with a proper law of shortening arrive at a system of non-Euclidian geometry which is essentially that of Lobatschewsky. But in so obtaining it we put out of sight its relation to spherical geometry: the three geometries (spherical, Euclidian, and Lobatschewsky's) should be regarded as members of a system; viz., they are the geometries of a plane (two-dimensional) space of constant positive curvature, zero curvature, and constant negative curvature respectively; or again, they are the plane geometries corresponding to three different notions of distance; in this point of view they are Klein's elliptic, parabolic, and hyperbolic geometries respectively.

Next as regards solid geometry: we can by a modification of the notion of distance (such as has just been explained in regard to Lobatschewsky's system) pass from our present system to a non-Euclidian system; for the other mode of passing to a non-Euclidian system it would be necessary to regard our space as a flat three-dimensional space existing in a space of four dimensions (*i.e.*, as the analogue of a plane existing in ordinary space), and to substitute for such flat three-dimensional space a curved three-dimensional space, say of constant positive or negative curvature. In regarding the physical space of our experience as possibly non-Euclidian, Riemann's idea seems to be that of modifying the notion of distance, not that of treating it as a locus in four-dimensional space.

I have just come to speak of four-dimensional space. What meaning do we attach to it? Or can we attach to it any meaning? It may be at once admitted that we cannot conceive of a fourth dimension of space; that space as we conceive of it, and the physical space of our experience, are alike three-dimensional; but we can, I think, conceive of space as being two- or even one-dimensional; we can imagine rational beings living in a one-dimensional space (a line), or in a two-dimensional space (a surface), and conceiving of space accordingly, and to whom, therefore, a two-dimensional space, or (as the case may be) a three-dimensional space, would be as inconceivable as a four-dimensional space is to us. And very curious speculative questions arise. Suppose the one-dimensional space a right line, and that it afterwards becomes a curved line, would there be any indication of the change? Or, if originally a curved line, would there be anything to suggest to them that it was not a right line? Probably not, for a one-dimensional geometry hardly exists. But let the space be two-dimensional, and imagine it originally a plane, and afterwards bent (converted, that is, into some form of developable surface) or converted into a curved surface; or imagine it originally a developable or curved surface. In the former case there should be an indication of the change, for the geometry originally applicable to the space of their experience (our own Euclidian geometry) would cease to be applicable; but the change could not be apprehended by them as a bending or deformation of the plane, for this would imply the notion of a three-dimensional space in which this bending or deformation could take place. In the latter case their geometry would be that appropriate to the developable or

curved surface which is their space; viz., this would be their Euclidian geometry: would they ever have arrived at our own more simple system? But take the case where the two-dimensional space is a plane, and imagine the beings of such a space familiar with our own Euclidian plane geometry; if, a third dimension being still inconceivable by them, they were by their geometry or otherwise led to the notion of it, there would be nothing to prevent them from forming a science such as our own science of three-dimensional geometry.

Evidently all the foregoing questions present themselves in regard to ourselves, and to three-dimensional space as we conceive of it, and as the physical space of our experience. And I need hardly say that the first step is the difficulty, and that granting a fourth dimension we may assume as many more dimensions as we please. But whatever answer be given to them, we have, as a branch of mathematics, potentially, if not actually, an analytical geometry of n -dimensional space. I shall have to speak again upon this.

Coming now to the fundamental notion already referred to, that of imaginary magnitude in analysis and imaginary space in geometry, I connect this with two great discoveries in mathematics made in the first half of the seventeenth century,—Harriot's representation of an equation in the form $f(x)=0$, and the consequent notion of the roots of an equation as derived from the linear factors of $f(x)$, (Harriot, 1560—1621; his "Algebra," published after his death, has the date 1631); and Descartes's method of co-ordinates, as given in the "Géométrie," forming a short supplement to his "Traité de la Méthode," &c. (Leyden, 1637).

Taking the coefficients of an equation to be real magnitudes, it at once follows from Harriot's form of an equation that an equation of the order n ought to have n roots. But it is by no means true that there are always n real roots. In particular, an equation of the second order, or quadric equation, may have no real root; but if we assume the existence of a root i of the quadric equation $x^2+1=0$, then the other root is $-i$; and it is easily seen that every quadric equation (with real coefficients as before) has two roots $a \pm bi$, where a and b are real magnitudes. We are thus led to the conception of an imaginary magnitude, $a+bi$, where a and b are real magnitudes, each susceptible of any positive or negative value, zero included. The general theorem is that, taking the coefficients of the equation to be imaginary magnitudes, then an equation of the order n has always n roots, each of them an imaginary magnitude, and it thus appears that the foregoing form $a+bi$ of imaginary magnitude is the only one that presents itself. Such imaginary magnitudes may be added or multiplied together, or dealt with in any manner; the result is always a like imaginary magnitude. They are thus the magnitudes which are considered in analysis, and analysis is the science of such magnitudes. Observe the leading character that the imaginary magnitude $a+bi$ is a magnitude composed of the two real magnitudes a and b (in the case $b=0$ it is the real magnitude a , and in the case $a=0$ it is the pure imaginary magnitude bi). The idea is that of considering, in place of real magnitudes, these imaginary or complex magnitudes $a+bi$.

In the Cartesian geometry a curve is determined by means of the equation existing between the co-ordinates (x, y) of any point thereof. In the case of a right line this equation is linear; in the case of a circle, or more generally of a conic, the equation is of the second order; and generally, when the equation is of the order n , the curve which it represents is said to be a curve of the order n . In the case of two given curves there are thus two equations satisfied by the co-ordinates (x, y) of the several points of intersection, and these give rise to an equation of a certain order for the co-ordinate x or y of a point of intersection. In the case of a straight line and a circle this is a quadric equation; it has two roots, real or

imaginary. There are thus two values, say of x , and to each of these corresponds a single value of y . There are therefore two points of intersection—viz., a straight line and a circle intersect *always* in two points, real or imaginary. It is in this way that we are led analytically to the notion of imaginary points in geometry. The conclusion as to the two points of intersection cannot be contradicted by experience: take a sheet of paper and draw on it the straight line and circle, and try. But you might say, or at least be strongly tempted to say, that it is meaningless. The question of course arises, What is the meaning of an imaginary point? and further, In what manner can the notion be arrived at geometrically?

There is a well-known construction in perspective for drawing lines through the intersection of two lines, which are so nearly parallel as not to meet within the limits of the sheet of paper. You have two given lines which do not meet, and you draw a third line, which, when the lines are all of them produced, is found to pass through the intersection of the given lines. If instead of lines we have two circular arcs not meeting each other, then we can, by means of these arcs, construct a line; and if on completing the circles it is found that the circles intersect each other in two real points, then it will be found that the line passes through these two points; if the circles appear not to intersect, then the line will appear not to intersect either of the circles. But the geometrical construction being in each case the same, we say that in the second case also the line passes through the two intersections of the circles.

Of course it may be said in reply that the conclusion is a very natural one, provided we assume the existence of imaginary points; and that, this assumption not being made, then, if the circles do not intersect, it is meaningless to assert that the line passes through their points of intersection. The difficulty is not got over by the analytical method before referred to, for this introduces difficulties of its own: is there in a plane a point the co-ordinates of which have given imaginary values? As a matter of fact we do consider in plane geometry imaginary points introduced into the theory analytically or geometrically as above.

The like considerations apply to solid geometry, and we thus arrive at the notion of imaginary space as a *locus in quo* of imaginary points and figures.

I have used the word imaginary rather than complex, and I repeat that the word has been used as including real. But, this once understood, the word becomes in many cases superfluous, and the use of it would even be misleading. Thus, "a problem has so many solutions"; this means so many imaginary (including real) solutions. But if it were said that the problem had "so many imaginary solutions," the word "imaginary" would here be understood to be used in opposition to real. I give this explanation the better to point out how wide the application of the notion of the imaginary is,—viz., (unless expressly or by implication excluded), it is a notion implied and presupposed in all the conclusions of modern analysis and geometry. It is, as I have said, the fundamental notion underlying and pervading the whole of these branches of mathematical science.

I shall speak later on of the great extension which is thereby given to geometry, but I wish now to consider the effect as regards the theory of a function. In the original point of view, and for the original purposes, a function, algebraic or transcendental, such as \sqrt{x} , $\sin x$, or $\log x$, was considered as known, when the value was known for every real value (positive or negative) of the argument; or if for any such values the value of the function became imaginary, then it was enough to know that for such values of the argument there was no real value of the function. But now this is not enough, and to know the function means to know its value—of course, in general, an imaginary value $X+iY$ —for every imaginary value $x+iy$ whatever of the argument.

And this leads naturally to the question of the geometrical representation of an imaginary variable. We represent the imaginary variable $x+iy$ by means of a point in a plane, the co-ordinates of which are (x, y) . This idea, due to Gauss, dates from about the year 1831. We thus picture to ourselves the succession of values of the imaginary variable $x+iy$ by means of the motion of the representative point; for instance, the succession of values corresponding to the motion of the point along a closed curve to its original position. The value $X+iY$ of the function can of course be represented by means of a point (taken for greater convenience in a different plane), the co-ordinates of which are X, Y .

We may consider in general two points, moving each in its own plane, so that the position of one of them determines the position of the other, and consequently the motion of the one determines the motion of the other; for instance, the two points may be the tracing-point and the pencil of a pentagraph. You may with the first point draw any figure you please, there will be a corresponding figure drawn by the second point: for a good pentagraph, a copy on a different scale (it may be); for a badly-adjusted pentagraph, a distorted copy; but the one figure will always be a sort of copy of the first, so that to each point of the one figure there will correspond a point of the other figure.

In the case above referred to, where one point represents the value $x+iy$ of the imaginary variable, and the other the value $X+iY$ of some function $\phi(x+iy)$ of that variable, there is a remarkable relation between the two figures: this is the relation of orthomorphic projection, the same which presents itself between a portion of the earth's surface, and the representation thereof by a map on the stereographic projection or on Mercator's projection,—viz., any indefinitely small area of the one figure is represented in the other figure by an indefinitely small area of the same shape. There will possibly be for different parts of the figure great variations of scale, but the shape will be unaltered; if for the one area the boundary is a circle, then for the other area the boundary will be a circle; if for one it is an equilateral triangle, then for the other it will be an equilateral triangle.

I have for simplicity assumed that to each point of either figure there corresponds one, and only one, point of the other figure; but the general case is that to each point of either figure there corresponds a determinate number of points in the other figure; and we have thence arising new and very complicated relations which I must just refer to. Suppose that to each point of the first figure there correspond in the second figure two points; say one of them is a red point, the other a blue point; so that, speaking roughly, the second figure consists of two copies of the first figure, a red copy and a blue copy, the one superimposed on the other. But the difficulty is that the two copies cannot be kept distinct from each other. If we consider in the first figure a closed curve of any kind—say, for shortness, an oval—this will be in the second figure represented in some cases by a red oval and a blue oval, but in other cases by an oval half red and half blue; or, what comes to the same thing, if in the first figure we consider a point which moves continuously in any manner, at last returning to its original position, and attempt to follow the corresponding points in the second figure, then it may very well happen that, for the corresponding point of either colour, there will be abrupt changes of position, or say jumps, from one position to another; so that, to obtain in the second figure a continuous path, we must at intervals allow the point to change from red to blue, or from blue to red. There are in the first figure certain critical points called branch-points (*Verzweigungs-punkte*), and a system of lines connecting these, by means of which the colours in the second figure are determined; but it is not possible for me to go further into the theory at present. The notion of colour has of course been introduced only for facility of expression; it may be proper to add that in speaking of the two figures

I have been following Briot and Bouquet rather than Riemann, whose representation of the function of an imaginary variable is a different one.

I have been speaking of an imaginary variable $(x+iy)$, and of a function $\phi(x+iy)=X+iY$ of that variable, but the theory may equally well be stated in regard to a plane curve: in fact, the $x+iy$ and the $X+iY$ are two imaginary variables connected by an equation; say their values are u and v , connected by an equation $F(u, v)=0$; then, regarding u, v as the co-ordinates of a point in *plano*, this will be a point on the curve represented by the equation. The curve, in the widest sense of the expression, is the whole series of points, real or imaginary, the co-ordinates of which satisfy the equation, and these are exhibited by the foregoing corresponding figures in two planes; but in the ordinary sense the curve is the series of real points, with co-ordinates u, v , which satisfy the equation.

In geometry it is the curve, whether defined by means of its equation, or in any other manner, which is the subject for contemplation and study. But we also use the curve as a representation of its equation—that is, of the relation existing between two magnitudes x, y , which are taken as the co-ordinates of a point on the curve. Such employment of a curve for all sorts of purposes—the fluctuations of the barometer, the Cambridge boat-races, or the Funds—is familiar to most of you. It is in like manner convenient in analysis, for exhibiting the relations between any three magnitudes, x, y, z , to regard them as the co-ordinates of a point in space; and, on the like ground, we should at least wish to regard any four or more magnitudes as the co-ordinates of a point in space of a corresponding number of dimensions. Starting with the hypothesis of such a space, and of points therein each determined by means of its co-ordinates, it is found possible to establish a system of n -dimensional geometry analogous in every respect to our two- and three-dimensional geometries, and to a very considerable extent serving to exhibit the relations of the variables. To quote from my memoir "On Abstract Geometry" (1869):—"The science presents itself in two ways: as a legitimate extension of the ordinary two- and three-dimensional geometries, and as a need in these geometries and in analysis generally. In fact, whenever we are concerned with quantities connected in any manner, and which are considered as variable or determinable, then the nature of the connection between the quantities is frequently rendered more intelligible by regarding them (if two or three in number) as the co-ordinates of a point in a plane or in space. For more than three quantities there is, from the greater complexity of the case, the greater need of such a representation; but this can only be obtained by means of the notion of a space of the proper dimensionality, and to use such representation we require a corresponding geometry. An important instance in plane geometry has already presented itself in the question of the number of curves which satisfy given conditions; the conditions imply relations between the coefficients in the equation of the curve; and for the better understanding of these relations it was expedient to consider the coefficients as the co-ordinates of a point in a space of the proper dimensionality."

It is to be borne in mind that the space, whatever its dimensionality may be, must always be regarded as an imaginary or complex space such as the two- or three-dimensional space of ordinary geometry; the advantages of the representation would otherwise altogether fail to be obtained.

I have spoken throughout of Cartesian coordinates; instead of these it is in plane geometry not unusual to employ trilinear co-ordinates, and these may be regarded as absolutely undermined in their magnitude—viz. we may take x, y, z to be, not equal, but only proportional to the distances of a point from three given lines; the ratios of the co-ordinates (x, y, z) determine the point; and so in one-dimensional geometry, we may have a point determined by the ratio of its two co-ordinates x, y , these co-or-

dinates being proportional to the distances of the point from two fixed points; and generally in n -dimensional geometry a point will be determined by the ratios of the $(n+1)$ co-ordinates (x, y, z, \dots) . The corresponding analytical change is in the expression of the original magnitudes as fractions with a common denominator; we thus, in place of rational and integral non-homogeneous functions of the original variables, introduce rational and integral homogeneous functions (quantics) of the next succeeding number of variables—viz., we have binary quantics corresponding to one-dimensional geometry, ternary to two-dimensional geometry, and so on.

It is a digression, but I wish to speak of the representation of points or figures in space upon a plane. In perspective we represent a point in space by means of the intersection with the plane of the picture (suppose a pane of glass) of the line drawn from the point to the eye, and doing this for each point of the object we obtain a representation or picture of the object. But such representation is an imperfect one, as not determining the object: we cannot by means of the picture alone find out the form of the object; in fact, for a given point of the picture the corresponding point of the object is not a determinate point, but it is a point anywhere in the line joining the eye with the point of the picture. To determine the object we need two pictures, such as we have in a plan and elevation, or, what is the same thing, in a representation on the system of Monge's descriptive geometry. But it is theoretically more simple to consider two projections on the same plane, with different positions of the eye: the point in space is here represented on the plane by means of two points which are such that the line joining them passes through a fixed point of the plane (this point is in fact the intersection with the plane of the picture of the line joining the two positions of the eye); the figure in space is thus represented on the plane by two figures, which are such that the lines joining corresponding points of the two figures pass always through the fixed point. And such two figures completely replace the figure in space; we can by means of them perform on the plane any constructions which could be performed on the figure in space, and employ them in the demonstration of properties relating to such figure. A curious extension has recently been made: two figures in space such that the lines joining corresponding points pass through a fixed point have been regarded by the Italian geometer Veronése as representations of a figure in four-dimensional space, and have been used for the demonstration of properties of such figure.

I referred to the connection of Mathematics with the notions of space and time, but I have hardly spoken of time. It is, I believe, usually considered that the notion of number is derived from that of time; thus Whewell in the work referred to, p. xx., says number is a modification of the conception of repetition, which belongs to that of time. I cannot recognise that this is so: it seems to me that we have (independently, I should say, of space or time, and in any case not more depending on time than on space) the notion of plurality; we think of, say the letters, a, b, c , &c., and thence in the case of a finite set—for instance a, b, c, d, e —we arrive at the notion of number; co-ordinating them one by one with any other set of things, or, suppose, with the words first, second, &c., we find that the last of them goes with the word fifth, and we say that the number of things is = five: the notion of cardinal number would thus appear to be derived from that of ordinal number.

Questions of combination and arrangement present themselves, and it might be possible from the mere notion of plurality to develop a branch of mathematical science; this, however, would apparently be of a very limited extent, and it is difficult *not* to introduce into it the notion of number; in fact, in the case of a finite set of things, to avoid asking the question, How many? If we do this, we

have a large enough subject, including the partition of numbers, which Sylvester has called *Tactic*.

From the notion thus arrived at of an integer number, we pass to that of a fractional number, and we see how by means of these the ratio of any two concrete magnitudes of the same time can be expressed, not with absolute accuracy, but with any degree of accuracy we please: for instance, a length is so many feet, tenths of a foot, hundredths, thousandths, &c.; subdivide as you please, *non constat* that the length can be expressed accurately, we have in fact incommensurables; as to the part which these play in the Theory of Numbers, I shall have to speak presently. for the moment I am only concerned with them in so far as they show that we cannot from the notion of number pass to that which is required in analysis, the notion of an abstract (real and positive) magnitude susceptible of continuous variation. The difficulty is got over by a Postulate. We consider an abstract (real and positive) magnitude, and regard it as susceptible of continuous variation, without in anywise concerning ourselves about the actual expression of the magnitude by a numerical fraction or otherwise.

There is an interesting paper by Sir W. R. Hamilton, "Theory of Conjugate Functions, or Algebraical Couples: with a preliminary and elementary Essay on Algebra as the Science of Pure Time," 1833-35 (*Trans. R. I. Acad.*, t. 17), in which, as appears by the title, he purposes to show that algebra is the science of pure time. He states there, in the General Introductory Remarks, his conclusions: first, that the notion of time is connected with existing algebra; second, that this notion or intuition of time may be unfolded into an independent pure science; and third, that the science of pure time thus unfolded is co-extensive and identical with algebra, so far as algebra itself is a science; and to sustain his first conclusion he remarks that "the history of algebraic science shows that the most remarkable discoveries in it have been made either expressly through the notion of *time*, or through the closely connected (and in some sort coincident) notion of continuous progression. It is the genius of algebra to consider what it reasons upon as *flowing*, as it was the genius of geometry to consider what it reasoned on as *fixed*. . . . And generally the revolution which Newton made in the higher parts of both pure and applied algebra was founded mainly on the notion of *fluxion*, which involves the notion of *time*." Hamilton uses the term algebra in a very wide sense, but whatever else he includes under it, he includes all that in contradistinction to the Differential Calculus would be called algebra. Using the word in this restricted sense, I cannot myself recognise the connection of algebra with the notion of time: granting that the notion of continuous progression presents itself, and is of importance, I do not see that it is in anywise the fundamental notion of the science. And still less can I appreciate the manner in which the author connects with the notion of time his algebraical couple, or imaginary magnitude $a + bi$ ($a + b\sqrt{-1}$, as written in the memoir).

I would go further: the notion of continuous variation is a very fundamental one, made a foundation in the Calculus of Fluxions (if not always so in the Differential Calculus) and presenting itself or implied throughout in mathematics: and it may be said that a change of any kind takes place only in time; it seems to me, however, that the changes which we consider in mathematics are for the most part considered quite irrespectively of time.

It appears to me that we do not have in Mathematics the notion of time until we bring it there: and that even in kinematics (the science of motion) we have very little to do with it; the motion is a hypothetical one; if the system be regarded as actually moving, the rate of motion is altogether undetermined and immaterial. The relative rates of motion of the different points of the system are nothing else than the ratios of purely geometrical quantities, the infinitely short distances simultaneously described, or which might be simultaneously described, by these points respectively. But whether the notion of time does or does

not sooner enter into mathematics, we at any rate have the notion in Mechanics, and along with it several other new notions.

Regarding Mechanics as divided into Statics and Dynamics, we have in dynamics the notion of time, and in connection with it that of velocity: we have in statics and dynamics the notion of force; and also a notion which in its most general form I would call that of *corpus*: viz., this may be, the material point or particle, the flexible inextensible string or surface, or the rigid body, of ordinary mechanics; the incompressible perfect fluid of hydrostatics and hydrodynamics; the ether of any undulatory theory; or any other imaginable corpus; for instance, one really deserving of consideration in any general treatise of mechanics is a developable or skew surface with absolutely rigid generating lines, but which can be bent about these generating lines, so that the element of surface between two consecutive lines rotates as a whole about one of them. We have besides, in dynamics necessarily, the notion of mass or inertia.

We seem to be thus passing out of pure mathematics into physical science; but it is difficult to draw the line of separation, or to say of large portions of the "*Principia*," and the "*Mécanique céleste*," or of the whole of the "*Mécanique analytique*," that they are not pure mathematics. It may be contended that we first come to physics when we attempt to make out the character of the corpus as it exists in nature. I do not at present speak of any physical theories which cannot be brought under the foregoing conception of mechanics.

I must return to the Theory of Numbers; the fundamental idea is here integer number: in the first instance positive integer number, but which may be extended to include negative integer number and zero. We have the notion of a product, and that of a prime number, which is not a product of other numbers; and thence also that of a number as the product of a determinate system of prime factors. We have here the elements of a theory in many respects analogous to algebra: an equation is to be solved—that is, we have to find the integer values (if any) which satisfy the equation; and so in other cases: the congruence notation, although of the very highest importance, does not affect the character of the theory.

But as already noticed we have incommensurables, and the consideration of these gives rise to a new universe of theory. We may take into consideration any surd number such as $\sqrt{2}$, and so consider numbers of the form $a + b\sqrt{2}$, (a and b any positive or negative integer numbers not excluding zero); calling these integer numbers, every problem which before presented itself in regard to integer numbers in the original and ordinary sense of the word presents itself equally in regard to integer numbers in this new sense of the word; of course all definitions must be altered accordingly: an ordinary integer, which is in the ordinary sense of the word a prime number, may very well be the product of two integers of the form $a + b\sqrt{2}$, and consequently not a prime number in the new sense of the word. Among the incommensurables which can be thus introduced into the Theory of Numbers (and which was in fact *first* so introduced) we have the imaginary i of ordinary analysis: viz., we may consider numbers $a + bi$ (a and b ordinary positive or negative integers, not excluding zero), and, calling these integer numbers, establish in regard to them a theory analogous to that which exists for ordinary real integers. The point which I wish to bring out is that the imaginary i does not in the Theory of Numbers occupy a unique position, such as it does in analysis and geometry; it is in the Theory of Numbers one out of an indefinite multitude of incommensurables.

I said that I would speak to you, not of the utility of mathematics in any of the questions of common life or of physical science, but rather of the obligations of mathematics to these different subjects. The consideration

which thus presents itself is in a great measure that of the history of the development of the different branches of mathematical science in connection with the older physical sciences, Astronomy and Mechanics: the mathematical theory is in the first instance suggested by some question of common life or of physical science, is pursued and studied quite independently thereof, and perhaps after a long interval comes in contact with it, or with quite a different question. Geometry and algebra must, I think, be considered as each of them originating in connection with objects or questions of common life—geometry, notwithstanding its name, hardly in the measurement of land, but rather from the contemplation of such forms as the straight line, the circle, the ball, the top (or sugar loaf): the Greek geometers appropriated for the geometrical forms corresponding to the last two of these, the words *κωνος* and *σφαῖρα*, our cone and sphere, and they extended the word cone to mean the complete figure obtained by producing the straight lines of the surface both ways indefinitely. And so algebra would seem to have arisen from the sort of easy puzzles in regard to numbers which may be made, either in the picturesque forms of the *Bija-Ganita* with its maiden with the beautiful locks, and its swarms of bees amid the fragrant blossoms, and the one queen-bee left humming around the lotus flower; or in the more prosaic form in which a student has presented to him in a modern text-book a problem leading to a simple equation.

The Greek geometry may be regarded as beginning with Plato (B.C. 430-347): the notions of geometrical analysis, loci, and the conic sections are attributed to him, and there are in his Dialogues many very interesting allusions to mathematical questions: in particular the passage in the "Theætetus," where he affirms the incommensurability of the sides of certain squares. But the earliest extant writings are those of Euclid (B.C. 285): there is hardly anything in mathematics more beautiful than his wondrous fifth book; and he has also in the seventh, eighth, ninth, and tenth books fully and ably developed the first principles of the Theory of Numbers, including the theory of incommensurables. We have next Apollonius (about B.C. 247), and Archimedes (B.C. 287-212), both geometers of the highest merit, and the latter of them the founder of the science of statics (including therein hydrostatics): his dictum about the lever, his *Εῦρηκα*, and the story of the defence of Syracuse, are well known. Following these we have a worthy series of names, including the astronomers Hipparchus (B.C. 150) and Ptolemy (A.D. 125), and ending, say, with Pappus (A.D. 400), but continued by their Arabian commentators, and the Italian and other European geometers of the sixteenth century and later, who pursued the Greek geometry.

The Greek arithmetic was, from the want of a proper notation, singularly cumbersome and difficult; and it was for the astronomical purposes superseded by the sexagesimal arithmetic, attributed to Ptolemy, but probably known before his time. The use of the present so-called Arabic figures became general among Arabian writers on arithmetic and astronomy about the middle of the tenth century, but was not introduced into Europe until about two centuries later. Algebra among the Greeks is represented almost exclusively by the treatise of Diophantus (A.D. 150), in fact a work on the Theory of Numbers containing questions relating to square and cube numbers, and other properties of numbers, with their solutions: this has no historical connection with the later algebra, introduced into Italy from the East by Leonardi Bonacci of Pisa (A.D. 1202-1208) and successfully cultivated in the fifteenth and sixteenth centuries by Lucas Pacioli, or de Burgo, Tartaglia, Cardan, and Ferrari. Later on, we have Vieta (1540-1603), Harriot, already referred to, Wallis, and others.

Astronomy is of course intimately connected with geometry; the most simple facts of observation of the heavenly bodies can only be stated in geometrical language: for instance, that the stars describe circles

about the pole-star, or that the different positions of the sun among the fixed stars in the course of the year form a circle. For astronomical calculations it was found necessary to determine the arc of a circle by means of its chord: the notion is as old as Hipparchus, a work of whom is referred to as consisting of twelve books on the chords of circular arcs; we have (A.D. 125) Ptolemy's "Almagest," the first book of which contains a table of arcs and chords with the method of construction; and among other theorems on the subject he gives there the theorem afterwards inserted in Euclid (Book VI. Prop. D) relating to the rectangle contained by the diagonals of a quadrilateral inscribed in a circle. The Arabians made the improvement of using in place of the chord of an arc the sine, or half chord of double the arc; and so brought the theory into the form in which it is used in modern trigonometry; the before-mentioned theorem of Ptolemy, or rather a particular case of it, translated into the notation of sines, gives the expression for the sine of the sum of two arcs in terms of the sines and cosines of the component arcs; and it is thus the fundamental theorem on the subject. We have in the fifteenth and sixteenth centuries a series of mathematicians who with wonderful enthusiasm and perseverance calculated tables of the trigonometrical or circular functions, Purbach, Müller, or Regiomontanus, Copernicus, Reinhold, Maurolycus, Vieta, and many others; the tabulations of the functions tangent and secant are due to Reinhold and Maurolycus respectively.

Logarithms were invented, not exclusively with reference to the calculation of trigonometrical tables, but in order to facilitate numerical calculations generally; the invention is due to John Napier of Merchiston, who died in 1618 at 67 years of age; the notion was based upon refined mathematical reasoning on the comparison of the spaces described by two points, the one moving with a uniform velocity, the other with a velocity varying according to a given law. It is to be observed that Napier's logarithms were nearly but not exactly those which are now called (sometimes Napierian, but more usually) hyperbolic logarithms—those to the base e ; and that the change to the base 10 (the great step by which the invention was perfected for the object in view) was indicated by Napier but actually made by Henry Briggs, afterwards Savilian Professor at Oxford (d. 1630). But it is the hyperbolic logarithm which is mathematically important. The direct function e^x or $\exp. x$, which has for its inverse the hyperbolic logarithm, presented itself, but not in a prominent way. Tables were calculated of the logarithms of numbers, and of those of the trigonometrical functions.

The circular functions and the logarithm were thus invented each for a practical purpose, separately and without any proper connection with each other. The functions are connected through the theory of imaginaries and form together a group of the utmost importance throughout mathematics: but this is mathematical theory; the obligation of mathematics is for the discovery of the functions.

Forms of spirals presented themselves in Greek architecture, and the curves were considered mathematically by Archimedes; the Greek geometers invented some other curves, more or less interesting, but recondite enough in their origin. A curve which might have presented itself to anybody, that described by a point in the circumference of a rolling carriage wheel, was first noticed by Mersenne in 1615, and is the curve afterwards considered by Roberval, Pascal, and others under the name of the Roulette, otherwise the Cycloid. Pascal (1623-1662) wrote at the age of seventeen his 'Essais pour les Coniques' in seven short pages, full of new views on these curves, and in which he gives, in a paragraph of eight lines, his theorem of the inscribed hexagon.

Kepler (1571-1630) by his empirical determination of the laws of planetary motion, brought into connection with astronomy one of the forms of conic, the ellipse, and established a foundation for the theory of gravitation,

Contemporary with him for most of his life, we have Galileo (1564-1642), the founder of the science of dynamics; and closely following upon Galileo we have Isaac Newton (1643-1727):—the '*Philosophiæ naturalis Principia Mathematica*' known as the '*Principia*' was first published in 1687.

The physical, statical, or dynamical questions which presented themselves before the publication of the '*Principia*' were of no particular mathematical difficulty, but it is quite otherwise with the crowd of interesting questions arising out of the theory of gravitation, and which, in becoming the subject of mathematical investigation, have contributed very much to the advance of mathematics. We have the problem of two bodies, or what is the same thing, that of the motion of a particle about a fixed centre of force, for any law of force; we have also the (mathematically very interesting) problem of the motion of a body attracted to two or more fixed centres of force; then, next preceding that of the actual solar system—the problem of three bodies; this has ever been and is far beyond the power of mathematics, and it is in the lunar and planetary theories replaced by what is mathematically a different problem, that of the motion of a body under the action of a principal central force and a disturbing force; or (in one mode of treatment) by the problem of disturbed elliptic motion. I would remark that we have here an instance in which an astronomical fact, the observed slow variation of the orbit of a planet, has directly suggested a mathematical method, applied to other dynamical problems, and which is the basis of very extensive modern investigations in regard to systems of differential equations. Again, immediately arising out of the theory of gravitation, we have the problem of finding the attraction of a solid body of any given form upon a particle, solved by Newton in the case of a homogeneous sphere, but which is far more difficult in the next succeeding cases of the spheroid of revolution (very ably treated by Maclaurin) and of the ellipsoid of three unequal axes: there is perhaps no problem of mathematics which has been treated by as great a variety of methods, or has given rise to so much interesting investigation as this last problem of the attraction of an ellipsoid upon an interior or exterior point. It was a dynamical problem, that of vibrating strings, by which Lagrange was led to the theory of the representation of a function as the sum of a series of multiple sines and cosines; and connected with this we have the expansions in terms of Legendre's functions P_n , suggested to him by the question just referred to of the attraction of an ellipsoid; the subsequent investigations of Laplace on the attractions of bodies differing slightly from the sphere led to the functions of two variables called Laplace's functions. I have been speaking of ellipsoids, but the general theory is that of attractions, which has become a very wide branch of modern mathematics; associated with it we have in particular the names of Gauss, Lejeune-Dirichlet, and Green; and I must not omit to mention that the theory is now one relating to n -dimensional space. Another great problem of celestial mechanics, that of the motion of the earth about its centre of gravity, in the most simple case, that of a body not acted upon by any forces, is a very interesting one in the mathematical point of view.

I may mention a few other instances where a practical or physical question has connected itself with the development of mathematical theory. I have spoken of two map projections—the stereographic, dating from Ptolemy; and Mercator's projection, invented by Edward Wright about the year 1600: each of these, as a particular case of the orthomorphic projection, belongs to the theory of the geometrical representation of an imaginary variable. I have spoken also of perspective, and of the representation of solid figures employed in Monge's descriptive geometry. Monge, it is well known, is the author of the geometrical theory of the curvature of surfaces and of curves of curvature: he was led to this theory by a problem of earth-work; from a given area covered with earth of uniform

thickness, to carry the earth and distribute it over an equal given area, with the least amount of cartage. For the solution of the corresponding problem in solid geometry he had to consider the intersecting normals of a surface, and so arrived at the curves of curvature. (See his *Mémoire sur les Déblais et les Remblais*, *Mem. de l'Acad.*, 1781.) The normals of a surface are, again, a particular case of a doubly infinite system of lines, and are so connected with the modern theories of congruences and complexes.

The undulatory theory of light led to Fresnel's wave-surface, a surface of the fourth order, by far the most interesting one which had then presented itself. A geometrical property of this surface, that of having tangent planes each touching it along a plane curve (in fact a circle), gave to Sir W. R. Hamilton the theory of conical refraction. The wave surface is now regarded in geometry as a particular case of Kummer's quartic surface, with sixteen conical points and sixteen singular tangent planes.

My imperfect acquaintance as well with the mathematics as the physics prevents me from speaking of the benefits which the theory of Partial Differential Equations has received from the hydrodynamical theory of vortex motion, and from the great physical theories of heat, electricity, magnetism, and energy.

It is difficult to give an idea of the vast extent of modern mathematics. This word 'extent' is not the right one:—I mean extent crowded with beautiful detail—not an extent of mere uniformity such as an objectless plain, but of a tract of beautiful country seen at first in the distance but which will bear to be rambled through and studied in every detail of hillside and valley, stream, rock, wood, and flower. But, as for anything else, so for a mathematical theory—beauty can be perceived, but not explained. As for mere extent, I can perhaps best illustrate this by speaking of the dates at which some of the great extensions have been made in several branches of mathematical science.

As regards geometry, I have already spoken of the invention of the Cartesian co-ordinates (1637). This gave to geometers the whole series of geometric curves of higher order than the conic sections: Curves of the third order, or cubic curves; curves of the fourth order, or quartic curves; and so on indefinitely. The first fruits of it were Newton's "*Enumeratio linearum tertii ordinis*," and the extremely interesting investigations of Maclaurin as to corresponding points on a cubic curve. This was at once enough to show that the new theory of cubic curves was a theory quite as beautiful and far more extensive than that of conics. And I must here refer to Euler's remark in the paper "*Sur une contradiction apparente dans la théorie des courbes planes*" ("*Berlin Memoirs*," 1748), in regard to the nine points of intersection of two cubic curves (viz., that when eight of the points are given the ninth point is thereby completely determined): this is not only a fundamental theorem in cubic curves (including in itself Pascal's theorem of the hexagon inscribed in a conic), but it introduces into plane geometry a new notion—that of the point-system, or system of the points of intersection of two curves.

A theory derived from the conic, that of polar reciprocals, led to the general notion of geometrical duality—viz., that in plane geometry the point and the line are correlative figures; and founded on this we have Plücker's great work, the "*Theorie der Algebraischen Curven*" (Bonn, 1839), in which he establishes the relation which exists between the order and class of a curve and the number of its different point- and line-singularities (Plücker's six equations). It thus appears that the true division of curves is not a division according to order only, but according to order and class, and that the curves of a given order and class are again to be divided into families according to their singularities: this is not a mere subdivision, but is really a widening of the field of investigation; each such family of curves is in itself a

subject as wide as the totality of the curves of a given order might previously have appeared.

We unite families by considering together the curves of a given *Geschlecht*, or deficiency; and in reference to what I shall have to say on the Abelian functions, I must speak of this notion introduced into geometry by Riemann in the memoir "Theorie der Abel'schen Functionen," Crelle, t. 54 (1857). For a curve of a given order, reckoning cusps as double points, the deficiency is equal to the greatest number $\frac{1}{2}(n-1)(n-2)$ of the double points which a curve of that order can have, less the number of double points which the curve actually has. Thus a conic, a cubic with one double point, a quartic with three double points, &c., are all curves of the deficiency 0; the general cubic is a curve, and the most simple curve, of the deficiency 1; the general quartic is a curve of deficiency 3; and so on. The deficiency is usually represented by the letter p . Riemann considers the general question of the rational transformation of a plane curve: viz., here the co-ordinates, assumed to be homogeneous or trilinear, are replaced by any rational and integral functions, homogeneous of the same degree in the new co-ordinates; the transformed curve is in general a curve of a different order, with its own system of double points; but the deficiency p remains unaltered; and it is on this ground that he unites together and regards as a single class the whole system of curves of a given deficiency p . It must not be supposed that all such curves admit of rational transformation the one into the other: there is the further theorem that any curve of the class depends, in the case of a cubic, upon one parameter, but for $p > 1$ upon $3p-3$ parameters, each such parameter being unaltered by the rational transformation; it is thus only the curves having the same one parameter, or $3p-3$ parameters, which can be rationally transformed the one into the other.

Solid geometry is a far wider subject: there are more theories, and each of them is of greater extent. The ratio is not that of the numbers of the dimensions of the spaces considered, or, what is the same thing, of the elementary figures—point and line in the one case; point, line, and plane in the other case—belonging to these spaces respectively, but it is a very much higher one. For it is very inadequate to say that in plane geometry we have the curve, and in solid geometry the curve and surface: a more complete statement is required for the comparison. In plane geometry we have the curve, which may be regarded as a singly infinite system of points, and also as a singly infinite system of lines. In solid geometry we have, first, that which under one aspect is the curve, and under another aspect the developable, and which may be regarded as a singly infinite system of points, of lines, or of planes; secondly, the surface, which may be regarded as a doubly infinite system of points or of planes, and also as a special triply infinite system of lines (viz., the tangent-lines of the surface are a special complex): as distinct particular cases of the former figure, we have the plane curve and the cone; and as a particular case of the latter figure, the ruled surface or singly infinite system of lines; we have besides the congruence, or doubly infinite system of lines, and the complex, or triply infinite system of lines. But, even if in solid geometry we attend only to the curve and the surface, there are crowds of theories which have scarcely any analogues in plane geometry. The relation of a curve to the various surfaces which can be drawn through it, or of a surface to the various curves that can be drawn upon it, is different in kind from that which in plane geometry most nearly corresponds to it, the relation of a system of points to the curves through them, or of a curve to the points upon it. In particular, there is nothing in plane geometry corresponding to the theory of the curves of curvature of a surface. To the single theorem of plane geometry, a right line is the shortest distance between two points, there correspond in solid geometry two extensive and difficult theories—that of the geodesic lines upon a given surface, and that of the surface of minimum area for any given boundary. Again,

in solid geometry we have the interesting and difficult question of the representation of a curve by means of equations; it is not every curve, but only the curve which is the complete intersection of two surfaces, which can be properly represented by two equations $(x, y, z, w)^m = 0$, $(x, y, z, w)^n = 0$, in quadriplanar co-ordinates; and in regard to this question, which may also be regarded as that of the classification of curves in space, we have quite recently three elaborate memoirs by Nöther, Halphen, and Valentiner respectively.

In n -dimensional geometry, only isolated questions have been considered. The field is simply too wide; the comparison with each other of the two cases of plane geometry and solid geometry is enough to show how the complexity and difficulty of the theory would increase with each successive dimension.

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Outside of ordinary mathematics, we have some theories which must be referred to: algebraical, geometrical, logical. It is, as in many other cases, difficult to draw the line; we do in ordinary mathematics use symbols not denoting quantities, which we nevertheless combine in the way of addition and multiplication, $a+b$, and ab , and which may be such as not to obey the commutative law $ab=ba$, in particular this is or may be so in regard to symbols of operation; and it could hardly be said that any development whatever of the theory of such symbols of operation did not belong to ordinary algebra. But I do separate from ordinary mathematics the system of multiple algebra or linear associative algebra, developed in the valuable memoir by the late Benjamin Peirce, "Linear Associative Algebra" (1870, reprinted 1881 in the *American Journal of Mathematics*, vol. iv., with notes and addenda by his son, C. S. Peirce); we here consider symbols A, B , &c., which are linear functions of a determinate number of letters or units i, j, k, l , &c., with coefficients which are ordinary analytical magnitudes, real or imaginary (viz., the coefficients are in general of the form $x+iy$, where i is the before-mentioned imaginary or $\sqrt{-1}$ of ordinary analysis). The letters i, j , &c., are such that every binary combination i^2, ij, ji , &c. (the ij being in general not $=ji$), is equal to a linear function of the letters, but under the restriction of satisfying the associative law: viz., for each combination of three letters ijk is $=ikj$, so that there is a determinate and unique product of three or more letters; or, what is the same thing, the laws of combination of the units i, j, k , are defined by a multiplication table giving the values of i^2, ij, ji , &c.; the original units may be replaced by linear functions of these units, so as to give rise, for the units finally adopted, to a multiplication table of the most simple form; and it is very remarkable, how frequently in these simplified forms we have nilpotent or idempotent symbols ($i^2=0$, or $i^2=i$, as the case may be), and symbols i, j , such that $ij=ji=0$; and consequently how simple are the forms of the multiplication tables which define the several systems respectively.

I have spoken of this multiple algebra before referring to various geometrical theories of earlier date, because I consider it as the general analytical basis, and the true basis, of these theories. I do not realise to myself directly the notions of the addition or multiplication of two lines, areas, rotations, forces, or other geometrical, kinematical, or mechanical entities; and I would formulate a general theory as follows:—Consider any such entity as determined by the proper number of parameters a, b, c (for instance, in the case of a finite line given in magnitude and position, these might be the length, the co-ordinates of one end, and the direction-cosines of the line considered as drawn from this end); and represent it by or connect it with the linear function $ai+bj+ck$ &c., formed with these parameters as coefficients, and with a given set of units, i, j, k , &c. Conversely, any such linear function represents an entity of the kind in question. Two given entities are represented by two linear functions; the sum

of these is a like linear function representing an entity of the same kind, which may be regarded as the sum of the two entities; and the product of them (taken in a determined order, when the order is material) is an entity of the same kind, which may be regarded as the product (in the same order) of the two entities. We thus establish by definition the notion of the sum of the two entities, and that of the product (in a determinate order, when the order is material) of the two entities. The value of the theory in regard to any kind of entity would of course depend on the choice of a system of units, $i, j, k \dots$ with such laws of combination as would give a geometrical or kinematical or mechanical significance to the notions of the sum and product as thus defined.

Among the geometrical theories referred to, we have a theory (that of Argand, Warren, and Peacock) of imaginaries in plane geometry; Sir W. R. Hamilton's very valuable and important theory of Quaternions; the theories developed in Grassmann's "Ausdehnungslehre," 1841 and 1862; Clifford's theory of Biquaternions, and recent extensions of Grassmann's theory to non-Euclidian space, by Mr. Homersham Cox. These different theories have of course been developed, not in anywise from the point of view in which I have been considering them, but from the points of view of their several authors respectively.

The literal symbols x, y , &c., used in Boole's "Laws of Thought" (1854), to represent things as subjects of our conceptions, are symbols obeying the laws of algebraic combination (the distributive, commutative, and associative laws) but which are such that for any one of them, say x , we have $x-x^2=0$, this equation not implying (as in ordinary algebra it would do) either $x=0$ or else $x=1$. In the latter part of the work relating to the Theory of Probabilities there is a difficulty in making out the precise meaning of the symbols, and the remarkable theory there developed has, it seems to me, passed out of notice, without having been properly discussed. A paper by the same author, "Of Propositions numerically Definite" (*Camb. Phil. Trans.*, 1869) is also on the borderland of logic and mathematics. It would be out of place to consider other systems of mathematical logic, but I will just mention that Mr. C. S. Peirce in his "Algebra of Logic" (*Amer. Math. Journal*, vol. iii.), establishes a notation for relative terms, and that these present themselves in connection with the systems of units of the linear associative algebra.

Connected with logic, but primarily mathematical and of the highest importance, we have Schubert's "Abzählende Geometrie" (1878). The general question is, How many curves or other figures are there which satisfy given conditions? for example, How many conics are there which touch each of five given conics? The class of questions, in regard to the conic, was first considered by Chasles, and we have his beautiful theory of the characteristics μ, ν , of the conics which satisfy four given conditions; questions relating to cubics and quartics were afterwards considered by Maillard and Zeuthen; and in the work just referred to the theory has become a very wide one. The noticeable point is that the symbols used by Schubert are in the first instance, not numbers, but mere logical symbols: for example, a letter g denotes the condition that a line shall cut a given line; g^2 that it shall cut each of two given lines; and so in other cases; and these logical symbols are combined together by algebraical laws: they first acquire a numerical significance when the number of conditions becomes equal to the number of parameters upon which the figure in question depends.

In all that I have last said in regard to theories outside of ordinary mathematics, I have been still speaking on the text of the vast extent of modern mathematics. In conclusion I would say that mathematics have steadily advanced from the time of the Greek geometers. Nothing is lost or wasted; the achievements of Euclid, Archimedes, and Apollonius are as admirable now as they were in their own days. Descartes's method of co-ordinates

is a possession for ever. But mathematics have never been cultivated more zealously and diligently, or with greater success, than in this century—in the last half of it, or at the present time: the advances made have been enormous, the actual field is boundless, the future full of hope. In regard to pure mathematics we may most confidently say:—

Yet I doubt not through the ages one increasing purpose runs,
And the thoughts of men are widened with the process of the suns.

PURIFICATION OF SULPHURETTED HYDROGEN GAS FOR CHEMICO-JUDICIAL INVESTIGATIONS.

By W. LENZ.

It has been repeatedly and urgently pointed out that the presence of arsenic in the iron sulphide used for generating sulphuretted hydrogen gas in chemico-legal investigations is liable to give off an arseniferous gas and thus introduce arsenic into the matter under examination. The author has repeatedly convinced himself, by means of Fresenius and Babo's very delicate method of reducing arsenic in a current of carbon dioxide that various sorts of commercial iron sulphide, sold as "free from arsenic" and "absolutely free from arsenic" on treatment with non-arsenical acids developed a sulphuretted hydrogen gas which conveyed not inconsiderable quantities of arsenic into the acid solution under examination.

Washing with water by no means frees the gas from arsenic, but this may be effected by washing with dilute hydrochloric acid. The author uses for this purpose a system of four washing bottles, set in a square upon a thick plate of iron and heated during the experiment to 60° — 70° . Each of the bottles contains about 22 c.c. of liquid; that in the first is a mixture of 1 part officinal acid (?) and 2 parts of water; the second contains a part of such acid to 4 parts of water, the third 1 part to 8 of water, and the fourth pure water. The bottles are closed with corks, not caoutchouc stoppers. The connection is made with glass tubes or tubes of non-vulcanised india-rubber. Sulphuretted hydrogen washed in this manner has been passed for hours into warm dilute hydrochloric acid without producing a deposit of arsenic sulphide, whilst a current of gas evolved from the same materials but washed only in water gave an arsenical precipitate on being passed into dilute acid for half an hour. —*Zeitschrift für Anal. Chemie.*

To this paper may be appended a memoir by W. Fresenius, found in the same number of the *Zeitschrift* on the presence of arsenic in glass as a source of error in the detection of arsenic. The author remarks that whilst in toxicological researches the reagents have been always carefully tested for arsenic, no one has suspected that the glass apparatus employed, if containing arsenic, might give occasion to errors. Such a result, however, appears, according to the author's observations, perfectly possible. It is well known that arsenious acid is often used in the manufacture of glass as a decolourising agent, and it seems that latterly arsenic is more generally and more abundantly present in glass, whether from a more copious addition of arsenious acid, or from the use of strongly arseniferous materials. The author's attention was first drawn to this subject when testing a precipitate formed by sulphuretted hydrogen for arsenic by Fresenius and Babo's process. The bulk of the precipitate, mixed with soda and potassium cyanide, placed in a tube of Bohemian glass, was heated in a current of carbonic acid for a short time and not too violently. There appeared only a very slight arsenical deposit. On repeating the experiment with the smaller residual portion of the precipitate, heat-

ing more strongly and for a longer time in a tube of the same glass, an extremely strong arsenical mirror. This phenomenon led to the supposition that the latter mirror was due to the glass which had been attacked by the melting mixture of potassium cyanide and sodium carbonate. To test this supposition the author made a blank experiment in a tube of the same glass, with a mixture of sodium carbonate and potassium cyanide perfectly free from arsenic. The result perfectly verified the supposition: if the heat was short and feeble there was no deposit, but after prolonged and vigorous heating a very strong mirror appeared in the tube. The author then examined certain kinds of glass for arsenic, and studied the influence which this impurity may have in the various methods for determining arsenic. The qualities tried were a Bohemian glass with which the foregoing experiments had been made, containing 0.20 per cent of arsenic and 0.05 of lead; a refractory glass from Thüringen containing 0.08 arsenic and 0.96 lead, and a third refractory glass containing per gramme a quantity of arsenic not ponderable and 0.09 per cent of lead. On making blank experiments as above with all these three kinds of glass, mirrors were obtained, that with the last kind being by far the slightest.

If the mixture was placed in a porcelain boat which had been previously ignited, and was thus prevented from coming in direct contact with the glass, the experiment being otherwise conducted exactly according to Fresenius and Babo's method, no arsenical mirror was obtained even on intense and prolonged heating. Pure sodium carbonate alone, if heated in a current of pure hydrogen gas, gave an arsenical with all three kinds of glass, though very slight with the last mentioned kind. A current of pure hydrogen alone produced no arsenical mirror, but with the two first mentioned kinds of glass there was produced a brown colouration at the spot where the flame played directly upon the glass. This browning has generally been attributed to the presence of lead, but the author considers it due to arsenic, as it was strongest in the Bohemian glass, which contained much arsenic but little lead, and did not appear at all in the third, which contained twice as much lead and a mere trace of arsenic.

Further experiments are made to show whether aqueous solutions of acids or alkalies were capable of taking up arsenic from glass. It was found that such an extraction is possible in case of alkaline liquids, but is not to be apprehended with acids.

The presence of arsenic in the glass is not likely to lead to error in the Marsh process, as it would be detected in the preliminary examination before adding the suspected substance.

In the Fresenius and Babo process, the substance with the reduction mixture should be placed in a porcelain boat, introduced into a tube of glass as free as possible from arsenic, and cautiously dried in the current of carbon dioxide before applying a high temperature. The author finally remarks that non-arsenical glass was formerly a common article of commerce, though it cannot now be procured.—*Zeitschrift für Anal. Chemie.*

The Chemical Laboratory of Wiesbaden.—In the Summer term, 1883, there were 49 students on the books. Of these, 36 were from Germany, 3 from England, 3 from North America, 2 from Luxemburg, 2 from Sweden, and 1 from Austro-Hungary, Spain, and Russia. Besides the Director, Geh. Hofrath Prof. Dr. R. Fresenius, there are engaged as teachers in the establishment: Dr. H. Fresenius, Dr. E. Borgmann, Dr. W. Fresenius, Dr. E. Hintz, and Architect F. Brahm. The assistants in the instruction laboratory were two in number; in the private laboratory, fourteen; and in the Versuchsstation, two. Besides scientific researches, numerous analyses were undertaken in the laboratory and the Versuchsstation on behalf of manufacture, trade, mining, and agriculture.

SEPARATIONS OF GALLIUM.

By M. LECOQ DE BOISBAUDRAN.

Separation from Tungsten.

THE various compounds of tungsten must first be brought to the state of ammoniacal or alkaline tungstates, —a transformation easily effected.

The mixture of tungstate and of gallium compounds is mixed with a decided excess of hydrochloric acid and evaporated in heat almost to dryness. During this operation the white tungstic acid is partially dehydrated, and turns yellow. We add then a little water, and evaporate afresh without entirely drying up the mass, upon which is then poured a considerable quantity of water very slightly acidulated with hydrochloric acid; it is then slightly heated and filtered.

The clear liquid, free from tungstic acid, contains the gallium. The precipitate retains only traces of gallium, which are easily removed by re-dissolving in ammonia, and evaporating a second time in presence of an excess of hydrochloric acid as indicated above.

Separation from Phosphoric Acid.

The author has studied three methods which give good results:—

1. In a liquid which contains from a quarter to one-third of its volume of concentrated hydrochloric acid, potassium ferrocyanide throws down the gallium, whilst the phosphoric acid remains in solution.

The precipitate of gallium ferrocyanide must be carefully washed with water, strongly charged with hydrochloric acid, or it may retain traces of phosphoric acid.

2. The solution is mixed with about one-third of its volume of concentrated nitric acid and the phosphoric acid is precipitated by means of ammonium molybdate, proceeding in the usual manner for determining phosphoric acid.

The separation of the gallium and the molybdenum contained in the filtrate is effected by the method described in the CHEMICAL NEWS, vol. xlvii., p. 62.

3. The detection of small quantities of gallium disseminated in large masses of phosphates is very readily effected by adding to the hydrochloric solution, slightly acid, an excess of acid ammonium acetate, and a certain quantity of arsenious acid dissolved in water, and treating the whole with a current of sulphuretted hydrogen.

The arsenic sulphide carries down the gallium; it is well washed with water containing a little acid ammonium acetate and sulphuretted hydrogen, and is then re-dissolved in *aqua regia* containing a large excess of hydrochloric acid. The nitric acid is destroyed by long boiling; the arsenic acid is reduced by sulphurous acid, and the very acid hydrochloric acid is treated with a current of sulphuretted hydrogen. Arsenic sulphide falls free from gallium, which is found in the filtrate.—*Comptes Rendus.*

CORRESPONDENCE.

SEPARATION OF IRON AND ALUMINIUM.

To the Editor of the Chemical News.

SIR,—In the CHEMICAL NEWS, vol. xlviii., p. 114, appears a translation of a memoir on the behaviour of the acetates of chromium, iron, and aluminium, by B. Reinitzer, concluding with the statement that "the method of separating ferric and aluminium salts in the form of basic acetates entirely loses its applicability in presence of chromic salts."

My own experiments conducted me to the same result many years ago, as will be seen by reference to "Bowman's Practical Chemistry," 7th Edition, 1878 (Table xiii., p. 160, and Note q, p. 172), of which I have the honour of being the

EDITOR.

September 7, 1883.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvi., No. 8, August 20, 1883.

Separations of Gallium.—Lecoq de Boisbaudran.—See p. 148.

Researches on Nitrogen Iodide: on Chemical Radiometers, or Photometers, with Nitrogen Iodide; on the Preparation in the Cold of Nitrogen, Ammonium Iodide, and Iodide, under the Influence of Light; and on the Double Copper and Nitrogen Iodide.—Antony Guyard.—This paper will, if possible, be inserted at length.

No. 9, August 27, 1883.

New Method of Preparing Phosphorus Oxy-chloride.—E. Dervin.—The author places in a stoppered retort holding from 750 to 1000 c.c., 500 grms. phosphorus trichloride, which must be pure, containing especially no free phosphorus, and connects the neck of the retort to an ascending refrigerator by means of a thick caoutchouc tube. When the apparatus is thus arranged there are dropped in at the tubulure by means of a funnel about 4 grms. potassium chlorate which has been previously fused and finely pulverised. When this dose has been introduced the retort is stoppered. The liquid heats and enters into ebullition; when this has ceased a second dose of chlorate is introduced with the same precautions, stoppering the retort as rapidly as possible, for this time ebullition sets in almost instantly. The additions of chlorate are thus continued until 160 grms. have been added. The end of the preparation is distinctly marked by the fact that the three last doses, being superfluous, no longer occasion ebullition in the liquid. The process requires about four hours. The whole is then distilled in the oil-bath, and the last portions of the oxy-chloride are expelled by a current of dry carbonic acid.

Zeitschrift für Analytische Chemie.

Vol. xxii., Part 3, 1883.

Electrolytic Determinations and Separations.—E. Hintz.—C. Luckow has stated that silver is deposited at the negative pole under the action of the current in a very bulky state from the solutions of the silver salts in ammonia or ammonium carbonate, whilst there is formed at the positive pole a little peroxide, which is soon reduced to metallic silver. J. Krutwig mentions now that silver may be deposited from an ammoniacal solution in presence of ammonium sulphate in a state fit for weighing if a current is applied at first only capable of yielding 150 c.c. of detonating gas hourly, and doubling its strength after the first half-hour. In two hours time 0.1 gm. of silver is deposited. The deposit is washed with hot water, which is slowly poured into the platinum capsule serving as a negative electrode. For separating iron from manganese Classen and Von Reiss propose to submit the double oxalates to the action of the current in presence of ammonium oxalate. Classen mentions since that the separation of the iron can be accelerated if, instead of ammonium oxalate, a mixture of potassium oxalate and ammonium oxalate is used for the formation of the double salts. The author recommends that the decomposition should be begun with two Bunsen elements with their electrodes at the respective distance of 3 centimetres, and as soon as manganese is deposited the strength of the current should be increased by the introduction of one or two more elements. After the reduction of the iron is completed Classen pours off the supernatant liquid, boils after the addition of soda-lye in order to decompose the

acid ammonium carbonate formed during the electrolysis, adding further sodium carbonate, and finally a few c.c. of sodium hypochlorite. The hydrated manganese peroxide is quickly deposited, filtered off, washed with hot water containing a little ammonium nitrate, and the precipitate is weighed as manganoso-manganic oxide. For the separation of iron, manganese, and phosphoric acid, Classen separates the iron from the manganese electrolytically as above, precipitates the latter as peroxide, acidulates the filtrate with hydrochloric acid, and determines the phosphoric acid as usual. If sulphuric acid is to be determined along with iron and manganese, the two metals are separated electrolytically from the double oxalates and the sulphuric acid is determined in the filtrate with barium chloride without previously removing the last traces of manganese with sodium hypochlorite. The separation of iron, manganese, and alumina is also effected as above, the alumina being found in the liquid filtered off from the manganese peroxide. The current must not be allowed to act after the iron is deposited. The separation of iron from chromium is effected electrolytically by throwing down the iron as metal from the ammonium double oxalates, and then oxidising the chromic oxide to chromic acid. If iron, manganese, chrome, and alumina are to be separated, the current is allowed to act upon the ammonium double oxalates until the conversion of the chromic oxide into chromic acid is complete. The liquid is poured off, boiled, precipitated while hot with soda-lye, and a few c.c. of sodium hypochlorite are added. The deposit of manganese contains a little chrome, and it is therefore, after filtration, re-dissolved in hydrochloric acid, and again precipitated with soda and sodium hypochlorite. The united filtrates, freed from manganese, are boiled with ammonium chloride in excess till all the alumina is deposited. All the chrome is contained in the filtrate as chromic acid. In the electrolysis of liquids containing nickel and manganese as double oxalates, the nickel is first deposited as metal, and then the manganese as peroxide. The separation of cobalt, zinc, copper, bismuth, and cadmium from manganese is effected in the same manner. The separation of iron from glucina can be effected electrolytically if double ammonium oxalates are formed by means of an excess of ammonium oxalate (without the potassium salt), and the iron is eliminated by a feeble current. In separating iron, glucina, and alumina, the same method is adopted. After the reduction of the iron the liquid is poured into another platinum capsule, and the current is kept up till all the alumina is deposited. The glucina is then thrown down from the filtrate by boiling. The separation of iron from zirconia and vanadium is effected in the same way as from glucina.

Detection and Determination of Small Quantities of Silver in Galena in the Moist Way.—J. Krutwig.—Already noticed.

Detection of Tin in Presence of Antimony.—M. Pattison Muir.—From the *CHEMICAL NEWS*.

Notes on the Determination of Nitrogen, especially in Manures.—W. Fresenius.—This memoir will appear at length.

Determination of Sugar.—MM. Soxhlet, Degener, and others.—This memoir does not admit of useful abstraction.

A New Adulterant of Ground Pepper.—C. Girard.—The material used consists of the kernels of olives, ground. If the suspected mixture is scattered upon a mixture of equal volumes of glycerin and water, the pepper floats upon the surface, whilst the olive-kernels sink.

Application of Sulpho-diazo-benzolic Acid for the Detection of Glucose.—M. Penzoldt.—The reagent is dissolved in 60 parts of water, made slightly alkaline with potassa, and added to an equal volume of urine which has been made strongly alkaline. If glucose is present the urine takes a light claret colour, which gradually deepens.

Examination of Fats.—This paper will be inserted at length.

Adulteration of Saffron.—J. Biel.—Genuine saffron does not stain petroleum ether, and can thus be distinguished from calendula flowers dyed with dinitro-cresol.

MISCELLANEOUS.

Schools of Chemistry, &c.—The following information was received too late for insertion in our Students' Number:—

FIRTH COLLEGE, SHEFFIELD.—*Professor of Chemistry.*—W. Carleton Williams, B.Sc., F.C.S.

Demonstrator and Assistant Lecturer.—L. T. O'Shea, F.C.S.

The Session will commence on Wednesday, October 3, 1883.

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Day Students may not enter for less than six hours a week. Students joining the Laboratory at Christmas will be charged two-thirds, and at Easter one-third of the Fees for the whole Session.

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An arrangement has been entered into with the Science and Art Department, South Kensington, which will enable Science Teachers to work in the Chemical Laboratory for two days a week on payment of one-quarter of the usual fee, the Department being willing to pay the remainder under certain conditions, of which full information may be obtained on application to the Registrar.

Evening Classes.—Lectures, Tuesday and Friday, 7 to 8; Class, 8 to 9. Fee, 5s. per term, or 9s. per two terms. Laboratory instruction, Monday and Wednesday, 6 to 9. Sessional Fee, three hours per week, £2 5s.; six, £4 8s.

NOTES AND QUERIES.

** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Agent in Decolourising Sugar.—Can any correspondent tell me what is the acting agent in animal charcoal in decolourising sugar solutions?—SUGAR REFINER.

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THE CHEMICAL NEWS.

VOL. XLVIII. No. 1244.

ADDRESS TO THE CHEMICAL SECTION OF THE BRITISH ASSOCIATION.

By J. H. GLADSTONE, Ph.D., F.R.S., V.P.C.S.,
President of the Section.

A SECTIONAL address usually consists either of a review of the work done in the particular science during the past year, or of an exposition of some branch of that science to which the speaker has given more especial attention. I propose to follow the latter of these practices, and shall ask the indulgence of my brother chemists while I endeavour to place before them some thoughts on the subject of Elements.

Though theoretical and practical chemistry are now intertwined, with manifest advantage to each, they appear to have been far apart in their origin. Practical chemistry arose from the arts of life, the knowledge empirically and laboriously acquired by the miner and metallurgist, the potter and the glass-worker, the cook and the perfumer. Theoretical chemistry derived its origin from cosmogony. In the childhood of the human race the question was eagerly put, "By what process were all things made?" and some of the answers given started the doctrine of elements. The earliest documentary evidence of the idea is probably contained in the Shoo King, the most esteemed of the Chinese classics for its antiquity. It is an historical work, and comprises a document of still more venerable age, called "The Great Plan, with its Nine Divisions," which purports to have been given by Heaven to the Great Yu, to teach him his royal duty and "the proper virtues of the various relations." Of course there are wide differences of opinion as to its date, but we can scarcely be wrong in considering it as older than Solomon's writings. The First Division of the Great Plan relates to the Five Elements. "The first is named Water; the second, Fire; the third, Wood; the fourth, Metal; the fifth, Earth. The nature of water is to soak and descend; of fire, to blaze and ascend; of wood, to be crooked and to be straight; of metal, to obey and to change; while the virtue of the earth is seen in seed-sowing and ingathering. That which soaks and descends becomes salt; that which blazes and ascends becomes bitter; that which is crooked and straight becomes sour; that which obeys and changes becomes acid; and from seed-sowing and ingathering comes sweetness."*

A similar idea of five elements was also common among the Indian races, and is stated by Prof. Rodwell to have been in existence before the fifteenth century B.C., but, though the number is the same, the elements themselves are not identical with those of the ancient Chinese classic; thus, in the Institutes of Menu, the "subtle ether" is spoken of as being the first created, from which, by transmutation, springs air, whence, by the operation of a change, rises light or fire; from this comes water, and from water is deposited earth. These five are curiously correlated with the five senses, and it is very evident that they are not looked upon as five independent material existences, but as derived from one another. This philosophy was accepted alike by Hindoos and Buddhists. It was largely extended over Asia, and found its way into Europe. It is best known to us in the writings of the Greeks. Among these people, however,

the elements were reduced to four—fire, air, earth, and water—though Aristotle endeavoured to restore the "blue ether" to its position as the most subtle and divine of them all. It is true that the fifth element, or "quinta essentia," was frequently spoken of by the early chemists, though the idea attaching to it was somewhat changed, and the four elements continued to retain their place in popular apprehension, and still retain it, even among many of the scholars who take degrees at our universities. The claim of wood to be considered an element seems never to have been recognised in the West, unless, indeed, we are to seek this origin for the choice of the word *ύλη* to signify that original chaotic material out of which, according to Plato and his school, all things were created.* The idea also of a primal element, from which the others, and everything else, were originated, was common in Greece, the difficulty being to decide which of the four had the greatest claim to this honour. Thales, as is well known, in the sixth century B.C. affirmed that water was the first principle of things; but Anaxamenes afterwards looked upon air, Heraclitus upon fire, and Theracleides on earth, as the primal element. This notion of elements, however, was essentially distinct from our own. It was always associated with the idea of the genesis of matter rather than with its ultimate analysis, and the idea of *simple* as contrasted with *compound* bodies probably never entered into the thoughts of the contending philosophers.

The modern idea appears to have had a totally different origin, and we must again travel back to China. There, also in the sixth century B.C., the great philosopher Lao-tse was meditating on the mysteries of the world and the soul, and his disciples founded the religion of Taou. They were materialists; nevertheless they believed in a "finer essence," or spirit, that rises from matter, and may become a star; thus they held that the souls of the five elements, water, metal, fire, wood, and earth, arose and became the five planets. These speculations naturally led to a search after the sublimated essences of things, and the means by which this immortality might be secured. It seems that at the time of Tsin-she-hwang, the builder of the Great Wall, about two centuries before Christ, many romantic stories were current of immortal men inhabiting islands in the Pacific Ocean. It was supposed that in these magical islands was found the "herb of immortality" growing, and that it gave them exemption from the lot of common mortals. The emperor determined to go in search of these islands, but some untoward event always prevented him.†

Some two or three centuries after this a Taouist, named Weipahyang, wrote a remarkable book called "The Uniting Bond." It contains a great deal about the changes of the heavenly bodies, and the mutual relation of Heaven and men; and then the author proceeds to explain some transformations of silver and water. About elixir he tells us, "What is white when first obtained becomes red after manipulation on being formed into the elixir" ("tan," meaning red or elixir). "That substance, an inch in diameter, consists of the black and the white, that is, water and metal combined. It is older than heaven and earth. It is most honourable and excellent. Around it, like a wall, are the sides of the cauldron. It is closed up and sealed on every side, and carefully watched. The thoughts must be undisturbed, and the temper calm, and the hour of its perfection anxiously waited for. The false chemist passes through various

* Students of the Apocrypha will remember the expression in the "Book of Wisdom," xi., 17, "ἡ παντοδύναμός σου χεὶρ καὶ κτίσασα τὸν κόσμον ἐξ ἀμόρφου ὕλης" ("Thy Almighty hand, that made the world of matter without form"). The same book contains two allusions to the ordinary elements, vii., 17, and xix., 18 to 20. The word *στοιχεῖον* is used in the New Testament only in a general sense (2 Pet., iii., 10), or in its more popular meaning of the first steps in knowledge.

† Nearly all the above statements relating to this Taouist alchemy are derived from the writings of the Rev. Joseph Edkins, of Pekin, and the matter is treated in greater detail in an article on the "Birth of Alchemy," in the *Argonaut*, vol. iii., p. 1.

* Quoted from the translation by the Rev. Dr. Legge. In that most obscure classic, the *Yi-King*, fire and water, wind and thunder, the ocean and the mountains, appear to be recognised as the elements.

operations in vain. He who is enlightened expels his evil passions, is delighted morning and night, forgets fame and wealth, comprehends the true objects of life, and gains supernatural powers. He cannot then be scorched by fire, nor drowned in water, &c. &c. . . . The cauldron is round like the full moon, and the stove beneath is shaped like the half moon. The lead ore is symbolised by the White Tiger; and it, like metal amongst the elements, belongs to the West. Mercury resembles the sun, and forms itself into sparkling globes; it is symbolised by the Blue Dragon belonging to the East, and it is assigned to the element wood. Gold is imperishable. Fire does not injure its lustre. Like the sun and moon it is unaffected by time. Therefore the elixir is called 'the Golden Elixir.' Life can be lengthened by eating the herb called Hu ma; how much more by taking the elixir, which is the essence of gold, the most imperishable of all things! The influence of the elixir, when partaken of, will extend to the four limbs; the countenance will become joyful; white hair will be turned black; new teeth will grow in the place of old ones, and age at once become youth. . . . Lead ore and mercury are the bases of the process by which the elixir is prepared; they are the hinge upon which the principles of light and darkness revolve."

This description suggests the idea that the elixir of the Taouists was the red sulphide of mercury—vermillion—for the preparation of which the Chinese are still famous. That Weipahyang believed in his own philosophy is testified by a writer named Ko-hung, who, about a century afterwards, wrote the lives of celebrated Taouists. He tells how the philosopher, after preparing the elixir, took it, with his disciples, into a wood, and gave it first to his dog, then took it himself, and was followed by one of his pupils. They all three died, but, it appears, rose to life again, and to immortality. This brilliant example did not remain without imitators; indeed, two emperors of the Tang family are said to have died from partaking of the elixir. This circumstance diminished its popularity, and alchemy ceased to be practised in the Celestial Empire.

At the beginning of the seventh century the doctrine of Lao-tse was in great favour at the Chinese court; learning was encouraged, and there was much enterprise. At the same time the disciples of Mahomed carried their arms and his doctrines over a large portion of Asia, and even to the Flowery Land. Throughout the eighth century there were frequent embassies between eastern and western Asia, wars with the Caliphs, and even a matrimonial alliance. We need not wonder, therefore, that the teachings of the Taouist alchemists penetrated westward to the Arabian philosophers. It was at this period that Yeber-Abou-Moussah-Djafer-al-Sofé, commonly called Geber, a Sabæan of great knowledge, started what to the West was a new philosophy about the transmutation of metals, the Philosopher's Stone, and the Elixir of Life; and this teaching was couched in highly poetic language, mixed with astrology and accompanied by religious directions and rites. He held that all metals were composed of mercury, sulphur, and arsenic, in various proportions, and that the noblest metal could be procured only by a very lengthy purification. It was in the salts of gold and silver that he looked for the Universal Medicine. Geber himself was an experimental philosopher, and the belief in transmutation led to the acquirement of a considerable amount of chemical knowledge amongst the alchemists of Arabia and Europe. This gradually brought about a conviction that the three reputed elementary bodies, mercury, sulphur, and salt or acid, were not really the originators of all things. There was a transition period, during which the notion was itself suffering a transmutation. The idea became gradually clearer that all material bodies were made up of certain constituents, which could not be decomposed any further, and which, therefore, should be considered as elementary. The introduction of quantitative methods compelled the overflow of mediæval chemistry, and led to the placing of the conception of simple and compound bodies upon the foundation of scientific fact.

Lavoisier, perhaps, deserves the greatest credit in this matter, while the labours of the other great chemists of the eighteenth and the beginning of the nineteenth centuries were in a great measure directed to the analysis of every conceivable material, whether solid, liquid, or gaseous. These have resulted in the table of so-called elements, now nearly seventy in number, to which fresh additions are constantly being made.

Of this ever-growing list of elements not one has been resolved into simpler bodies for three-quarters of a century; and we, who are removed by two or three generations from the great builders of our science, are tempted to look upon these bodies as though they were really simple forms of matter, not only unresolved, but unresolvable. The notation we employ favours this view and stamps it upon our minds.

Is it, however, a fact that these reputed elements are really simple bodies? or, indeed, are they widely different in the nature of their constitution from those bodies which we know to be chemical compounds? Thus, to take a particular instance, are fluorine, chlorine, bromine, and iodine essentially distinct in their nature from the compound halogens, cyanogen, sulphocyanogen, ferricyanogen, &c.? Are the metals lithium, sodium, and potassium, essentially distinct from such alkaline bases as ammonium, ethylamine, di-ethylamine, &c.? No philosophical chemist would probably venture to answer this question categorically with either "yes" or "no." Let us endeavour to approach it from three different points of attack—(1) the evidence of the spectroscope, (2) certain peculiarities of the atomic weights, and (3) specific refraction.

1. *The Spectroscope.*—It was at first hoped that the spectroscope might throw much light upon the nature of elements, and might reveal a common constituent in two or more of them; thus, for instance, it was conceivable that the spectrum lines of bromine or iodine vapour might consist of the rays given by chlorine *plus* some others. All expectations of this have hitherto been disappointed: what we do frequently find is a certain similarity of character among the spectra of analogous elements, not rays of identically the same refrangibility. Yet, on the other hand, it must not be supposed that a negative result disproves the compound nature of elements, for as investigation proceeds it becomes more and more clear that the spectrum of a compound is not made up of the spectra of its component parts.

Again, the multiplicity of rays given out by some elements, when heated, in a gaseous condition, such as iron, has been supposed to indicate a more complex constitution than in the case of those metals, such as magnesium, which give a more simple spectrum. Yet it is perfectly conceivable that this may be due to a complexity of arrangement of atoms all of the same kind.

Again, we have changes of a spectrum at different temperatures; new rays appear, others disappear; or even there occurs the very remarkable change from a fluted spectrum to one of sharp lines at irregular intervals, or to certain recurring groups of lines. This, in all probability, does arise from some redistribution, but it may be a redistribution in a molecular grouping of atoms of the same kind, and not a dissociation or rearrangement of dissimilar atoms.

A stronger argument has been derived from the revelations of the spectroscope in regard to the luminous atmospheres of the sun. There we can watch the effect of heat enormously transcending that of our hottest furnaces, and of movements compared with which our hurricanes and whirlwinds are the gentlest of zephyrs. Mr. Lockyer, in studying the prismatic spectra of the luminous prominences or spots of the sun, has frequently observed that on certain days certain lines, say of the iron spectrum, are non-existent, and on other days certain other lines disappear, and that in almost endless variety; and he has also remarked that occasionally certain lines of the iron spectrum will be crooked or displaced, thus showing the vapour to be in very rapid motion, while others are straight,

and therefore comparatively at rest. Now, as a gas cannot be both at rest and in motion at the same time and the same place, it seems very clear that the two sets of lines must originate in two distinct layers of atmosphere, one above the other, and Mr. Lockyer's conclusion is that the iron molecule was dissociated by heat, and that its different constituents, on account of their different volatility, or some other cause, had floated away from one another. This seems to me the easiest explanation of the phenomenon; and, as dissociation by heat is a very common occurrence, there is no *a priori* improbability about it. But we are not shut up to it, for the different layers of atmosphere are certainly at different temperatures, and most probably of different composition. If they are of different temperatures, the variations of the spectrum may only be an extreme case of what must be acknowledged to be a fact by everyone more or less—that bodies emit, or cease to emit, different rays as their temperature increases, and notably when they pass from the liquid to the gaseous condition. And again, if the composition of the two layers of atmosphere be different, we have lately learnt how profoundly the admixture of a foreign substance will sometimes modify a luminous spectrum.

2. *Peculiarities of Atomic Weights.*—At the meeting of this Association at Ipswich, in 1851, M. Dumas showed that in several cases analogous elements form groups of three, the middle one of which has an atomic weight intermediate between those of the first and third, and that many of its physical and chemical properties are intermediate also. During the discussion upon his paper, and, subsequently,* attention was drawn to the fact that this is not confined to groups of three, but that there exists many series of analogous elements having atomic weights which differ by certain increments, and that these increments are in most cases multiples of 8. Thus we have lithium, 7; sodium, 23, *i. e.* $7 + 16$; potassium, 39, *i. e.* $7 + (16 \times 2)$; and the more recently discovered rubidium, 85, *i. e.* $7 + (16 \times 5)$ nearly; and caesium, 133, *i. e.* $7 + (16 \times 8)$ nearly. This is closely analogous to what we find in organic chemistry, where there are series of analogous bodies playing the part of metals, such as hydrogen, methyl, ethyl, &c., differing by an increment which has the atomic weight 14, and which we know† to be CH_2 . Again, there are elements with atomic weights nearly the same or nearly multiples of one another, instances of which are to be found in the great platinum group and the great cerium group.† This suggests the analogy of isomeric and polymeric bodies. There is also this remarkable circumstance: the various members of such a group as either of those just mentioned are found together at certain spots on the surface of the globe, and scarcely anywhere else. The chemist may be reminded of how in the dry distillation of some organic body he has obtained a mixture of polymerised hydrocarbons, and may perhaps be excused if he speculates whether in the process of formation of the platinum or the cerium group, however and whenever it took place, the different elements had been made from one another and imperfectly polymerised.

But this is not the largest generalisation in regard to the peculiarities of these atomic weights. Newlands showed that, by arranging the numbers in their order, the octaves presented remarkable similarities, and, on the same principle, Mendelieff constructed his well-known table. I may remind you that in this table the atomic weights are arranged in horizontal and vertical series, those in the vertical series differing from one another, as a rule, by the before-mentioned multiples of 8—namely 16, 16, 24, 24, 24, 32, 32—the elements being generally analogous in their atomicity and in other chemical characters. Attached to the elements are figures, representing various physical properties, and these in the horizontal series appear as periodic functions of the atomic weights.

The table is incomplete, especially in its lower portions but, with all its imperfections and irregularities, there can be no doubt that it expresses a great truth of nature. Now, if we were to interpolate the compound bodies which act like elements—methyl, 15; ammonium, 18; cyanogen, 20—into Mendelieff's table, they would be utterly out of place, and would upset the order both of chemical analogy and of the periodicity of the physical properties.

Specific Refraction.—The specific refraction has been determined for a large majority of the elements, and is a very fundamental property, which belongs to them apparently in all their combinations, so long at least as the atomicity* is unchanged. If the figures representing this property be inserted into Mendelieff's table, we find that in the vertical columns the figures almost invariably decrease as the atomic weights increase. If, however, we look along the horizontal columns, or better still if we plot the figures in the table by which Lothar Meyer has shown graphically that the molecular volume is a periodic function of the atomic weights, we shall see that they arrange themselves in a series of curves similar to but not at all coincident with his. The observations are not so complete or accurate as those of the molecular volumes, but they seem sufficient to establish the fact, while the points of the curves would appear to be, not the alkaline metals, as in Meyer's diagram, but hydrogen, phosphorus, and sulphur, titanium and vanadium, selenium, antimony. Now, if we were to insert the specific refractions of cyanogen, ammonium, and methyl into this table, we should again show that it was an intrusion of strangers not in harmony with the family of elements.

But there is another argument to be derived from the action of light. The refraction equivalent of a compound body is the sum of the refraction equivalents of its compounds; and, if there is anything known for certain in the whole subject, it is that the refraction equivalent of an organic compound advances by the same quantity (7.6) for every increment of CH_2 . If, therefore, the increment between the different members of a group of analogous elements, such as the alkaline metals, be of the same character, we may expect to find that there is a regular increase of the refraction equivalent for each addition of 16. But this is utterly at variance with fact: thus, in the instance above quoted, the refraction equivalent of lithium being 3.8, that of sodium is 4.8, of potassium 8.1, of rubidium 14.0, and of caesium about 13.7. Neither does the law obtain in those series in which the increment is not a multiple of 8, as in the case of the halogens, where the increment of atomic weight is 45, and the refraction equivalents are chlorine 9.9, bromine 15.3, and iodine 24.5.

The refraction equivalents of isomeric bodies are generally identical; and the refraction equivalents of polymeric bodies are in proportion to their atomic weights. Among the groups of analogous elements of the same, or nearly the same, atomic weight we do find certain analogies: thus cobalt and nickel are respectively 10.8 and 10.4, while iron and manganese are respectively 12.0 and 12.2. But, as far as observation has gone at present, we have reason to conclude that if metals stand to one another in the ratio of 2 : 1 in atomic weight, their refraction equivalents are much nearer together than that; while on the other hand, the equivalent of sulphur, instead of being the double of that of oxygen, is at least five times as great.

The general tendency of these arguments is evidently to show that the elementary radicals are essentially different from the compound radicals, though their chemical functions are similar.

There remains still the hypothesis that there is a "primordial element," from which the others are derived by transmutation. With the sages of Asia it was the "blue ether," with Thales water, with Dr. Prout hydrogen. The earlier views have passed away, and the claims of hydro-

* *Phil. Mag.*, May, 1853.

† Another curious instance is the occurrence of nickel and cobalt in all meteoric irons, with occasionally chromium or manganese, the atomic weights and other properties of which are very similar.

* This exception includes not merely such changes as that from a ferrous to a ferric salt, but the different ways in which the carbon is combined in such bodies as ethene, benzene, and pyrene.

gen are being fought out by some of our ablest analysts on the battle-field of atomic weights and their rigorous determination.

There does not appear to be any argument which is fatal to the idea that two or more of our supposed elements may differ from one another rather in form than in substance, or even that the whole seventy are only modifications of a prime element; but chemical analogies seem wanting. The closest analogy would be if we could prepare two allotropic conditions of some body, such as phosphorus or cyanogen, which should carry their allotropism into all their respective compounds, no compound of the one form being capable of change into a compound of the other. Our present knowledge of allotropism, and of variations in atomicity, affords little, if any, promise of this.

The remarkable relations between the atomic weights of the elements, and many peculiarities of their grouping, force upon us the conviction that they are not separate bodies created without reference to one another, but that they have been originally fashioned, or have been built up from one another, according to some general plan. This plan we may hope gradually to understand better; but if we are ever to transform one of these supposed elements into another, or to split up one of them into two or three dissimilar forms of matter, it will probably be by the application of some method of analysis hitherto unknown.

Nothing can be of greater promise than the discovery of new methods of research; hence I need make no apology to others who have lately done excellent work in chemistry if I single out the Bakerian Lecture of this year, by Mr. Crookes, on "Radiant Matter Spectroscopy." It relates to the prismatic analysis, not of the light transmitted or absorbed in the ordinary way by a solid or liquid, nor of that given out by incandescent gas, but the analysis of the fluorescence that manifests itself in certain bodies when they are exposed to an electric discharge in a highly exhausted vacuum. He describes, in an interesting and even amusing manner, his three years' quest after the origin of a certain citron band, which he observed in the spectrum of the fluorescence of many substances, till he was led into that wonderful labyrinth of uncertain elements which are found together in samarskite, and eventually he proved the appearance to be due to yttrium. As the test is an extremely delicate one, he has obtained evidence of the very general dissemination of that element, in very minute quantities—and not always very minute, for the polypes that built up a certain pink coral were evidently able to separate the earth from the sea water, as their calcareous secretion contained about $\frac{1}{2}$ per cent of yttrium. We have reason to hope that this is only the first instalment of discoveries to be made by this new method of research.

I cannot conclude without a reference to the brightening prospects of technical chemistry in this country. I do not allude to the progress of any particular industry, but to the increased facilities for the education of those engaged in the chemical manufactures. First as to the workpeople. Hitherto the young artizan has had little opportunity of learning at school what would be of the greatest service to him in his after career. The traditions of the Middle Ages were all in favour of literary culture for the upper classes, and the education suited for these has been retained in our schools for the sons of the people. It is true that some knowledge of common things has been given in the best schools, and the Education Department has lately encouraged the teaching of certain sciences in the upper standards. In the Mundella Code, however, which came into operation last year, "elementary science" may receive a grant in all the classes of a boys' or girls' school, and in the suggested scheme there is mentioned simple lessons on "the chemical and physical principles involved in one of the chief industries of England, among which Agriculture may be reckoned," while "Chemistry" is inserted among "the specific subjects of instruction," that may be given to the older children. It is impossible, as yet, to form an estimate of the extent to which managers and

teachers have availed themselves of this permission, for the examinations of her Majesty's Inspectors under the new code have only just commenced; but one of the best of the Board schools in London has just passed satisfactorily in chemistry both with boys and girls. I trust that in those parts of the country where chemical industries prevail chemistry may be largely taken up in our elementary schools.

The great deficiency in our present educational arrangements is the want of the means of teaching a lad who has just left the common school the principles of that industry by which he is to earn his livelihood. The more purely scientific chemistry, however, may be learnt by him now in those evening classes which may be formed under the Education Department, as well as in those that have long been established under the Science and Art Department. The large amount of attention that is now being given to the subject of technical education is creating in our manufacturing centres many technical classes and colleges for students of older growth.

As to inventors and the owners of our chemical factories, in addition to the Chemical Society and the Chemical Institute, there has recently been founded the Society of Chemical Industry. It came into existence with much promise of success; at the close of its second year it numbered 1,400 members; it has now powerful sections in London, Manchester, Liverpool, Newcastle, and Birmingham; and it diffuses information on technical subjects in a well-conducted monthly journal.

May the abstract science and its useful applications ever prove helpful to one another, and become more and more one chemistry for the benefit of mankind.

ON THE NITROCYANIDE OF SILVER.

By C. L. BLOXAM.

THIS salt is described in Gmelin's "Handbook of Chemistry," English Translation, vol. viii., p. 29, as formed by dissolving recently-precipitated silver cyanide in a somewhat concentrated solution of silver nitrate. Its composition is given as $\text{AgO} \cdot \text{NO}_5 + 2\text{AgCy}$, which, in the atomic notation, becomes $\text{AgNO}_3 \cdot 2\text{AgCy}$. In support of this formula (which is also given in "Watts's Dictionary") a determination of silver by Wöhler is given, as 69.74 per cent, whereas the formula requires 73.97.

I prepared a quantity of the salt by dissolving pure silver cyanide in a nearly saturated boiling solution of silver nitrate. On cooling, the liquid was filled with beautiful needles, which shrank into a much smaller bulk on moving the beaker. As water decomposes the salt, it was dried by repeated pressure between filter-paper.

20.51 grains of the salt, dried at 100°C ., became slightly brown, but lost only 0.07 grain (≈ 0.34 per cent).

52.1 grains, of another preparation, lost 0.27 grain (≈ 0.53 per cent). As the salt detonates when further heated, it was mixed with 3 parts of ignited sodium carbonate, and heated in a current of dry air which was afterwards passed into sulphuric acid bulbs previously weighed.

27.85 grains of the salt gave, when heated by a Bunsen burner, only 0.3 grain of water (≈ 1.07 per cent), confirming the statement in Gmelin, that the salt does not contain water (as an essential constituent).

20.44 grains of the salt dried at 100° , dissolved in concentrated nitric acid, and precipitated by hydrochloric acid, gave 18.458 grains of silver chloride, corresponding to 68.09 per cent of silver.

15.22 grains of another sample, which had been dried at 100° and finely powdered, were digested with water till completely decomposed. The undissolved silver cyanide was collected on a filter, washed, and ignited. It gave 5.27 grains of silver present as cyanide. The filtrate and

washings, precipitated by hydrochloric acid, gave 13.92 grains of silver chloride, corresponding to 10.47 grains of silver present as nitrate, or almost exactly twice that present as cyanide.

The composition of the salt therefore is $\text{AgCN} \cdot 2\text{AgNO}_3$.

	Found.	Calculated.
Ag as AgCN	22.97	22.77
Ag as AgNO ₃	45.64	45.55
	68.61	68.32

The slight excess of silver would be expected from the discolouration of the salt in drying.

The mother-liquor from the crystals contains silver nitrate only.

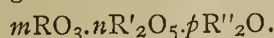
In the margin of the paragraph on nitrocyanoide of silver in Gmelin, I find a manuscript note by Hadow to the effect that "crystals found by Dawson to produce *pin-holes* in collodion negatives proved to be of this composition. March 17, 1865." At that date Hadow was Demonstrator of Chemistry and Dawson Lecturer on Photography in this College.

King's College, London, September 10, 1883.

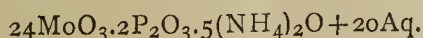
ON COMPLEX INORGANIC ACIDS.

By WOLCOTT GIBBS, M.D.,
Rumford Professor in Harvard University.

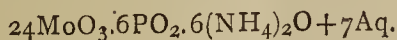
My further investigations of the complex inorganic acids have yielded results of very interesting character, and the field of work has become so extensive that it is simply impossible for one man to attempt to cover the whole ground. In the papers which I have already published I have described only binary compounds, such as may be expressed by the general formula—



In this formula m may represent any even number from 10 to 48 inclusive, R either molybdenum or tungsten, n is 2 in the compounds described, r, p the number of molecules of base (old style), while R' represents either phosphorus or arsenic. I have now generalised these results still further. In place of phosphorus or arsenic we may have vanadium or antimony, and probably niobium and tantalum, as I stated long since in a preliminary notice. In place of oxides of the type $\text{R}'_2\text{O}_3$, as, for example, As_2O_3 , Sb_2O_3 , P_2O_3 , and probably V_2O_3 . Thus, the formula of a phosphoroso-molybdate of ammonium is—



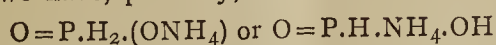
These compounds by oxidation pass into salts containing the higher oxides of the type $\text{R}'_2\text{O}_5$. Salts containing boric oxide, B_2O_3 , have been described by Klein. Even hypo-phosphorous acid is capable of forming similar compounds. Thus, I have obtained a hypo-phospho-molybdate with the formulæ—



Perhaps further study will show that the analyses may be represented by a simpler formula. A different mode of expression must be adopted, if, with Wurtz, we write the formula of hypo-phosphorous acid:—

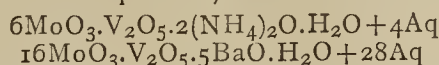


so that we have, probably, either



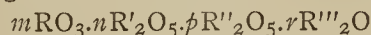
as the term representing the phosphorus contained, the type being still $\text{O} = \text{P} \equiv (\text{OH})_3$ as in phosphoric acid, part of the ammonium being united to WO_2 in the structural

formula. Well defined and beautifully crystalline vanadio-molybdates have respectively the formulæ—

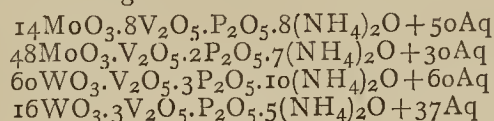


which correspond to types of phospho-molybdates and phospho-tungstates. In like manner in two vanadio-tungstates of sodium the ratios of the tungstic and vanadic oxides are respectively as 10:1 and as 18:1.

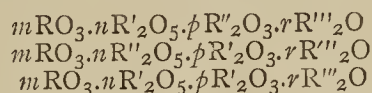
Ternary series containing tungstic or molybdic oxide united to two other oxides also exist in large number. Thus, in the general formula—



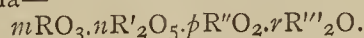
RO_3 may be either tungstic or molybdic oxide, $\text{R}'_2\text{O}_5$ and $\text{R}''_2\text{O}_5$ two different oxides of the same type, as, for example, phosphoric and vanadic oxides. I am not prepared to say that *any* two known oxides of the type R_2O_5 may enter together into such compounds, but it is not impossible that such is the case. Examples of these salts are the following:—



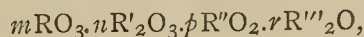
I refrain from theory at present, and simply remark, first, that some of these compounds are almost certainly double salts, and, secondly, that in certain cases very simple formulæ are obtained if we suppose that V_2O_5 , with the atomic structure $\text{V}_2\text{O}_2.\text{O}_3$, may replace WO_3 or MoO_3 , while with the formula V_2O_5 it replaces P_2O_5 . Other ternary series contain oxides of two types united to tungstic or molybdic oxide. Thus we have the general formulæ:—



in which R_2O_5 may be P_2O_5 , V_2O_5 , As_2O_5 , or Sb_2O_5 , perhaps also Nb_2O_5 and Ta_2O_5 , and R_2O_3 may be B_2O_3 , P_2O_3 , V_2O_3 , As_2O_3 , Sb_2O_3 . It will be seen that such compounds may be very numerous, especially if m, n , and p , may vary within wide limits. There is, however, at least one other group of ternary compounds reducible to the general formula—

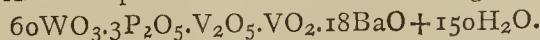


I have obtained a few salts belonging to such series. Finally, it seems probable that there is also a series embraced in the formula—

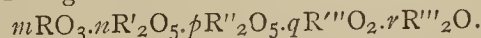


but I have not yet obtained compounds of this type.

Quaternary compounds of various types appear to exist. An example of these is the following:—

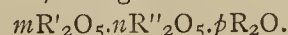


This is almost certainly a double or triple salt, but still shows how five different oxides may exist in a single well-defined and beautifully crystallised compound. The general formula here would be—



This possible number of combinations, if we take all the oxides not basic belonging to the four different types, and in addition give various values to m, n, p , and q , must be very great.

Besides the types which I have given above I have obtained others of an entirely different character, and not containing either molybdenum or tungsten. To this class belong phospho-vanadates, arsenio-vanadates, and antimonio-vanadates, the general formula being—



The salts are often beautifully crystallised and well defined.

I reserve to myself the right to work in any part of this field of research, since the generalisations are exclusively my own; but at the same time I invite other

chemists to enter the same field, probably the widest which has been opened up in the domain of inorganic chemistry. The results which I have given above were communicated to the National Academy of Sciences at the April and November sessions of the year 1882, but some little time must elapse before I can fully complete another instalment of my work.—*Am. Chem. Journ.*

ON AN APPARATUS FOR RAPID ANALYSIS OF GASES.

By A. A. BRENNEMAN, S.B.

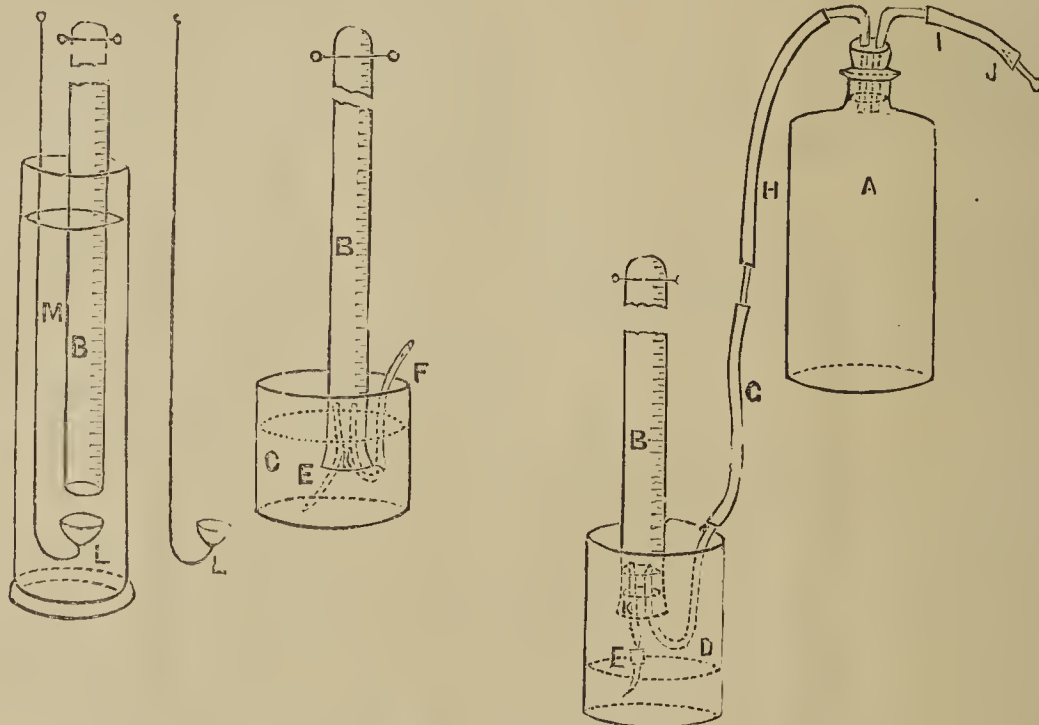
THE apparatus here described is designed for rapid analysis of gaseous mixtures where only a moderate degree of accuracy is required. It is possible nevertheless to secure very good results with it, if it be carefully handled, and if its known source of error be guarded against. As an example of the results that may be obtained with it, two analyses of air may be quoted which yielded respectively 21.04 per cent and 21.13 per cent by volume of oxygen instead of 20.96 per cent, which is probably a fair average for the most accurate analyses. The oxygen was absorbed by a solution of pyrogallic acid

by means of the deep spoon L to the measuring cylinder, the volume of the gas is noted with the existing temperature, the burette is again brought to the trough, K is inserted, and then by opening the valve F the level of water in the burette is brought to the inner surface of the cork K, the water passing into the exhaust bottle L. This bottle is used in the same way subsequently to receive all drainings and rinsing water from the burette.

The absorption liquids are introduced by bringing the point of the tube below E into the liquid and opening E; liquid rushes into the partially exhausted tube to replace the water previously withdrawn.

The burette is shaken to distribute the liquid over its sides, and more of the liquid is introduced as the absorption proceeds. When absorption is complete the liquid is withdrawn as before, the tube is rinsed with successive small quantities of water, and the gas finally measured again over water in the cylinder M.

The obvious errors of the apparatus are the entrance of air about the cork K, and separation of gases from the liquids used in the burette when the level of the liquid in the latter is reduced. A soft, well-fitting rubber stopper will remove the first objection, and as an additional precaution the mouth of the burette is kept below the surface



in caustic potash, in the proportion of 2 grms. of the solid acid to 5 c.c. of a solution of KHO (sticks) in twice its weight of water, and 10 c.c. of water were further added to the solution. The absorption of oxygen in each case occupied about twelve minutes. The excess of oxygen indicated is probably to be accounted for by the solution of part of the gaseous mixture in the water used for rinsing, but the error belongs to all absorption methods of analysis where the gas is measured over water.

The apparatus and its use will be readily understood from the accompanying diagram. A is a bottle holding a litre or more. It is closed by a soft rubber stopper carrying two tubes, one of which communicates with a water air-pump, the other with the gas burette. After exhausting the bottle at the pump, the tube I is closed by the stopper: F G H is already closed by a bit of stirring rod, plugging the rubber tube G at F, and serving also as a valve. It is opened by simply pinching up a portion of the rubber tube about it, thus forming a channel around the plug. The gas burette B is closed by a rubber stopper K, carrying two tubes, one of which connects with A; the other carries a valve at E and a pointed tube of glass at its end.

The gas burette is filled with gas over the pneumatic trough C, the cork K being removed. It is then transferred

of the water whenever it is not necessary to manipulate the burette. In practice the entrance of external air through leakage is inappreciable during the time of the analysis.

The second source of error is avoided by using such quantities of absorbing liquids that the diminution of pressure within the burette may be slight. During the time of greatest exhaustion, that is during the withdrawal of liquids, the current tends to carry minute bubbles that may separate downwards and into the bottle, and with a good vacuum (20.25 inches of mercury) in the latter, the time is too short to permit of any important volume of gas separating from the liquid.—*Journ. Am. Chem. Soc.*

EDWARD DAVY; A PIONEER OF THE ELECTRIC TELEGRAPH.*

EVERYONE who has acquired the slightest acquaintance with the history of science is well aware that many of the grandest ideas and discoveries that mark out new eras in

* Honour to whom honour is due! Edward Davy and the Electric Telegraph, 1836 to 1839, by J. J. Fahie. London: Office of the *Electrician*.

the advancement of the different branches of science have been conceived or worked out independently, and often contemporaneously, by different men, totally ignorant of each other's existence. In our own branch of science we at once call to mind the discovery of the composition of the atmosphere, of oxygen, and the composition of water; the stoichiometric equivalents of Richter and Wenzel and the atomic theory of Higgins and Dalton. In more recent times the discoveries in spectroscopy and many others in pure chemistry may be brought forward to confirm the point in question. This strange fact of the independence and frequently contemporaneity of similar ideas is exhibited in almost any branch of science we like to select, and consequently it is not to be wondered at if the just claims of many men to participate in the honour due to the thinker or experimenter who confers a lasting benefit upon mankind are often lost in oblivion.

There is at present alive and well, practising as a surgeon in Australia, an old gentleman named Edward Davy, who almost half a century ago conceived, and actually carried some of his ideas into effect, the germ—ay, and more than the germ—of what is now considered the wonder of the age, the electric telegraph, and who was on the very verge of giving to the world the Davy's system instead of what was accepted as the Cooke and Wheatstone system of telegraphy. What Davy's ideas were and what he accomplished that entitles him to an honourable recognition as one of the pioneers of the electric telegraph, considering the very crude notions held by even the most successful experimenters of that time, are simply amazing. His manuscripts which have recently been brought to light (thanks to the efforts of Mr. J. J. Fahie, of the Society of Telegraphic Engineers, and of Davy's nephew, Dr. H. Davy, of Exeter) show the wonderful grasp he had obtained of the principles of telegraphy. Sketching out in 1836, when the idea first occurred to him of employing electricity as a means of communication, his plans, he wrote,—“Let us suppose a number of copper wires, each covered with silk and varnished, to be laid underground, side by side, from London to Liverpool. For greater protection they may be enclosed in an iron pipe. If there be a small brass ball at each end of each wire, an electric spark applied to the ball at the London end of any of them might be drawn at the same instant from the corresponding ball at the Liverpool end.” Such a plan as this, however, was not the one Davy recommended in practice. He devised means by which to employ the Voltaic current; the signals being indicated by forming the receiving ends of the wires into coils of from five to two hundred turns arranged in a row, in the magnetic meridian, and in each being suspended a sensitive magnetic needle carrying a letter marked upon it. The feeblest current, wrote Davy, would produce a deflection, but if from the great distance that the electricity had to travel it became too feeble its effect on the needles could be increased by multiplying the convolutions of the coils. Thus was his method rendered well nigh theoretically perfect, but among other devices that he conceived to render the signals perceptible was this—“a piece of soft iron may be surrounded by a helix of copper wire so as to form a temporary magnet which will attract and relinquish a small piece of iron carrying the signal letter at every make and break of the current”—and “instead of steel needles, coils of copper wire may be deflected in the neighbourhood of fixed magnets.” Then followed the idea of diminishing the number of wires to be employed by using right and left deflections of the needles, until about the commencement of 1837 he had so perfected and improved his apparatus that he obtained permission from the Commissioners of Woods and Forests to lay down a mile of copper wire round the inner circle of the Regent's Park, with which he successfully experimented. About March of that year Davy heard of Prof. Wheatstone's experiments, and to secure his position he gave to Mr. Aikin, then the Secretary of the Society of Arts, a sealed packet containing the description of his invention. To his other improvements Davy designed what he called the “Electrical Re-

newer,” or the instrument now known as the “Relay,” and so rendered his system practicable. In May, 1837, when Cooke and Wheatstone made application for their first patent, Davy opposed it, and handed to the Solicitor-General a document containing a full description of his apparatus. In this document he described the parts of his telegraph as—“1st. Signal and alarm arrangements. 2nd. Originating mechanism. 3rd. Conducting and continuing arrangements.” To show how far his ideas and apparatus were in accord with those that have been or are now employed, the following extracts from this document will indicate. The signals and alarms “are effected by a number of galvanometer needles, and conducting wires, each of which terminates in a double coil which acts upon two needles. The form of the coil is that of the figure 8 (only the loops are made rectangular), and in each loop a magnetic needle is suspended. The whole is so arranged that all the needles point north and south. By means of pins or stops each needle is prevented from having its signal pole deflected except in one direction. It is then evident that if the electric current be passing in one direction the upper needle only, and if in the other direction, the lower needle only, will be deflected.” For the conducting and continuing arrangements Davy stated that “the best mode of laying the conducting wires remains to be determined by experience on a large scale, and the localities through which they may have to be brought. Either they may be somewhat flattened between rollers, and bound together with interposed pieces of cloth, soaked in pitch or rosin, &c., the whole being enveloped with canvas tarred, or impregnated with melted caoutchouc and linseed oil, or the like; or they may be secured in a tube.” “In the former case they would admit of being suspended in the air, from post to post, protected by lightning conductors.” The principle of his electrical renewer was described thus:—“The principle of this contrivance is that, the total distance being divided into a number of shorter ones, there be a separate galvanic circuit for each, and that, at the termination of each length of wire, its current be made to produce a motion, which establishes a communication between a fresh source of electricity and the wire which extends through the next succeeding distance . . .” “By this contrivance it is clear that there can be no physical limit to the distance to which electric currents may be carried, and, therefore, the expense of long distances will cease to be in an increased ratio to that of short ones.” Among his “additional observations” in this document is indicated clearly the grasp he had obtained of telegraphy and its applications. “Portable Telegraphs.—Such a contrivance might occasionally be useful in warfare.” “Marine Telegraphs.—Communications may be effected through or under the water by enclosing the conductors in ropes well coated or soaked, in an insulating and protecting varnish, as melted caoutchouc, &c. The ropes could then be sunk to a certain depth by weights and supported by small floats, or buoys. In connection with the rope we may have an air-tight and water-tight electrical renewing apparatus at each requisite interval.”

In addition to all this theory and experiment Davy brought his system before the notice of the public; about the end of 1837 a working model was shown at the Belgrave Institution, London, and for eleven months of the succeeding year he publicly exhibited his telegraph in a room, rented for the purpose, in Exeter Hall. In the *Mechanics Magazine*, too, his arrangements were described by persons who had inspected the exhibit.

Towards the end of 1837 Davy conceived the idea of a recording telegraph, but owing to the opposition of Cooke and Wheatstone it was not until the middle of the next year that the specification was sealed. Professor Faraday, who was consulted at the time regarding the rival claims, considered the two inventions to be distinct.

That Davy and Cooke and Wheatstone were engaged working out similar ideas with regard to the needle telegraph, the following extract from Davy's statement, written about that time, will show, and to what extent his

claims deserve recognition:—"In May, 1837 Messrs. Cooke and Wheatstone applied for a patent to which I entered opposition, having provided myself with a written description of my inventions and prepared to attest it by the evidence of several confidential friends. This evidence will be partly direct and partly corroborative. . . ." The Solicitor-General at the time gave an opinion that the two inventions were different, and allowed the patent to pass, although time has since shown that they contained some of the clearest identities.

"My remedies for the injustice thus sustained are, that I may move a writ of *scire facias* to set aside and annul Messrs. Cooke and Co.'s patent, on the ground that the Crown was misled in granting it, or else, or after failing that, to act upon the invention so that they may bring an action for infringement, which I have ample grounds for defending, and the failure of which will *virtually* render their patent void."

Having accomplished so much for telegraphy Davy's foresight was not slow in showing him how numerous would be the advantages possessed by such a rapid means of communication—preventing accidents on the railways and facilitating rapid travelling. "The finger of the London correspondent is on the finger key; and, anon, in less time than he can remove it, the signal is already on the paper in Edinburgh, and almost as fast as he can touch one key after another in succession these signals are formed into words and intelligent sentences. These may either have private interpretation attached to them easily arranged between individuals, or they may be translated according to rule by a clerk of the establishment, *supposing such an establishment thrown open to the public, like the Post Office*, on the principle that anyone might send a communication on paying some moderate fee, to be charged according to length."

Why, after having carried his ideas and experiment to such perfection, did Davy not succeed in getting his system taken up and worked into a practical form instead of allowing his rivals Cooke and Wheatstone a clear field seems a mystery. A few feeble attempts were made to get the Railway Companies to make a trial of his telegraph and to obtain the assistance of financiers, but just at that critical moment private affairs compelled him to leave England for Australia in the spring of 1839, and now the world knows only of the Cooke and Wheatstone telegraph.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.
Chief Chemist to the U.S. Geological Survey, Washington.

STRONTIUM.

THE ratios which fix the atomic weight of strontium resemble in general terms those relating to barium, only they are fewer in number and represent a comparatively small amount of work. The early experiments of Stromeyer,† who measured the volume of CO₂ evolved from a known weight of strontium carbonate, are hardly available for the present discussion. So also we may exclude the determination by Salvétat,‡ who neglected to publish sufficient details.

Taking the ratio between strontium chloride and silver first in order, we have series of figures by Pelouze and by Dumas. Pelouze|| employed the volumetric method already described under barium, and in two experiments obtained the subjoined results. In another column I append the ratio between SrCl₂ and 100 parts of silver:—

* Smithsonian Miscellaneous Collections. "The Constants of Nature."

† Schweigg. Journ., 19, 228. 1816.

‡ Comptes Rendus, 17, 318. 1843.

|| Comptes Rendus, 20, 1047. 1845.

1.480 grms. SrCl ₂	= 2.014 grms. Ag.	73.486
2.210 " "	3.008 " "	73.471

Mean 73.4781 ± 0.0050

Dumas,* by the same general method, made sets of experiments with three samples of chloride which had previously been fused in a current of dry hydrochloric acid. His results, expressed in the usual way, are as follows:—

Series A.

3.137 grms. SrCl ₂	= 4.280 Ag.	Ratio 73.2944
1.982 " "	2.705 " "	73.2717
3.041 " "	4.142 " "	73.4186
3.099 " "	4.219 " "	73.4534

Mean 73.3595 ± 0.0303

Series B.

3.356 grms. SrCl ₂	= 4.574 Ag.	Ratio 73.3713
6.3645 " "	8.667 " "	73.4327
7.131 " "	9.712 " "	73.4246

Mean 73.4095 ± 0.0130

Series C.

7.213 grms. SrCl ₂	= 9.811 Ag.	Ratio 73.5195
2.206 " "	3.006 " "	73.3866
4.268 " "	5.816 " "	73.5529
4.018 " "	5.477 " "	73.3613

Mean 73.4551 ± 0.0321

Combining, we have:—

Pelouze	73.4781 ± 0.0050
Dumas, A	73.3595 0.0303
" B	73.4095 0.0130
" C	73.4551 0.0321

General mean .. 73.4655 ± 0.0046

The foregoing figures apply to anhydrous strontium chloride. The ratio between silver and the crystallised salt, SrCl₂.6H₂O, has also been determined in two series of experiments by Marignac.† Five grms. of salt were used in each estimation, and, in the second series, the percentage of water was first determined. The quantities of the salt corresponding to 100 parts of silver are given in the last column:—

Series A.

5 grms. SrCl ₂ .6H ₂ O	= 4.0515 grms. Ag.	123.411
" "	4.0495 "	123.472
" "	4.0505 "	123.442

Mean 123.442 ± 0.012

Series B.

5 grms. SrCl ₂ .6H ₂ O	= 4.0490 grms. Ag.	123.487
" "	4.0500 "	123.457
" "	4.0490 "	123.487

Mean 123.477 ± 0.007

General mean of both series 123.470 ± 0.006

In the same paper Marignac gives two sets of determinations of the percentage of water in crystallised strontium chloride. The first set, corresponding to "B" above, comes out thus:—

40.556
40.568
40.566

Mean 40.563 ± 0.0024

* Ann. Chim. Phys. (3), 55, 29. 1859. Ann. Chem. Pharm., 113, 34.
† Journ. f. Prakt. Chem., 74, 216. 1858

In the second set ten grms. of salt were taken at a time and the following percentages were found:—

40.58
40.59
40.58

Mean 40.583 \pm 0.0020

General mean, from both series 40.575 \pm 0.0015

The chloride used in the series of estimations last given was subsequently employed for ascertaining the ratio between it and the sulphate. Converted directly into sulphate, 100 parts of chloride yield the quantities given in the third column:—

5.942 grms. SrCl_2 gave	6.887 SrSO_4 .	115.932
5.941	6.8855	115.949
5.942	6.884	115.927

Mean 115.936 \pm 0.004

Now, to sum up the ratios and calculate the atomic weight of strontium:—

(1.) Ag :	SrCl_2	:: 100 :	73.4655 \pm 0.0046
(2.) Ag :	$\text{SrCl}_2.6\text{H}_2\text{O}$	:: 100 :	123.470 0.006
(3.) Per cent of H_2O in $\text{SrCl}_2.6\text{H}_2\text{O}$,	40.575		0.0015
(4.) SrCl_2 :	SrSO_4	:: 100 :	115.936 0.004

We have now the molecular weight of SrCl_2 , as follows:—

From (1)	.. ..	$\text{SrCl}_2 = 158.208 \pm 0.017$
From (2)	.. ..	" = 158.113 0.034
From (3)	.. ..	" = 157.852 0.032

General mean.. .. = 158.124 \pm 0.014

And for the atomic weight of strontium itself we have two values as follows:—

1. From mol. wt. of SrCl_2 ..	$\text{Sr} = 87.384 \pm 0.032$
2. From (4)	" = 86.765 0.244

General mean.. .. = 87.374 \pm 0.032

If O = 16, then $\text{Sr} = 87.575$.

(To be continued.)

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING AUGUST 31ST, 1883.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the Water Examiner, Metropolis Water Act, 1871.

London, September 7th, 1883.

SIR,—We beg to submit to you a statement of the results of our examination of the 182 samples of water collected by us during the month of August, at the times and places indicated, from the mains of the seven London companies taking their supply from the Thames and the Lea; together with some remarks on the character of the supply during the preceding month.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from August 1st to August 31st inclusive. The purity of the water, in respect of organic matter, has been determined by the Oxygen and the Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples submitted for analysis.

Of the 182 samples of water submitted to examination, the whole, excepting three samples, one of which was recorded as "very slightly turbid" and two as "slightly turbid," were clear, bright, and well filtered. In respect to aëration, and freedom from colour and excess of organic matter, they have maintained the excellent character exhibited now for many months past.

In Dr. Frankland's report to the Registrar-General, on the character of the waters supplied to the Metropolis during the month of July, it is stated that "The Thames water supplied by the Chelsea, &c., Companies was again, for River water, unusually free from organic matter;" and then, a little further on, that "The deep well water distributed by the Kent, &c., Companies was of its usual excellent quality for drinking, and in freedom from organic matters surpassed any of the River waters;" this mode of disparaging river-water in an official, and presumably impartial report, seeming to be thought by the writer a fitting way of declaring his individual dissent from the conclusions in favour of river-water come to by Parliamentary and Royal Commissions, notwithstanding his own adverse evidence.

In the same July report to the Registrar-General, it is stated that the so-called "organic impurity" of the river-derived supply of London is from two to three times as great as that present in the well-water supply of the Kent Company, selected as a standard. It is not, however, pointed out, *per contra*, that the so-called "previous sewage contamination" of the standard well-water is from two to nearly three times as great as that of the river-derived water; although the reporter's own figures, establishing alike the two results, are as authoritative in the one case as in the other.*

We are, Sir,

Your obedient Servants,

WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Zeitschrift für Analytische Chemie.
Vol. xxii., Part 3, 1883.

Volumetric Determination of Mercury.—A. Hasa well.—The solutions required are:—Permanganate of known efficacy; ferrous sulphate acidified with sulphuric acid and standardised according to the permanganate employed, and a moderately concentrated solution of stannic chloride, containing neither free chlorine nor

* It is not meant seriously to imply that the well-water is rendered unwholesome by reason of its unquestionable excess of what has been called by Dr. Frankland "previous sewage contamination," any more than that the river-derived water is rendered unwholesome by reason of its unquestioned excess of what he calls "Organic impurity." Only, if at a period of general anxiety with respect to the threatenings of an epidemic outbreak, it is justifiable, as a means of exciting prejudice and alarm, to measure river-water by a well-water standard, and persistently to stigmatise a characteristic constituent of the river-water supplied to some four millions of people by a nasty-sounding name, it must be equally justifiable (?), with the same worthy object, to measure well-water by a river-water standard, and to stigmatise a characteristic constituent of the well-water supplied to less than half a million of people, by a similarly nasty-sounding name, also the offspring of Dr. Frankland's happy invention.

stannous oxide. It is prepared by dissolving pure tin in hydrochloric acid with the addition of potassium chlorate, boiling the solution until all chlorine has evaporated and precipitating with sodium carbonate. The filtered precipitate dissolved in hydrochloric acid should be reddened for at least three hours by a single drop of permanganate. In the execution of the process the solution of mercuric chloride, measured off with the pipette, is mixed with a known excess of the ferrous sulphate, and supersaturated with pure potassa. The blackish brown precipitate thus formed is digested for a few seconds, shaking the glass, acidified then with sulphuric acid of a moderate strength, and agitated till the permanent precipitate of mercurous chloride appears perfectly white. The excess of ferrous oxide is then at once oxidised with permanganate without filtration. This process may be regarded as complete when the milk-white liquid takes a peach-blossom colour. For the titration of the mercury a few drops of the stannic chloride are added, and permanganate is run in till the liquid is coloured a permanent red. The liquid becomes gradually clearer during the addition of the permanganate, but it does not always become quite limpid.

Determination of Glycerin in Soap Lyes.—M. Flemming.—The author neutralises 25 c.c. with dilute sulphuric acid, precipitates the fatty acids present with a minimum of milk of lime, and concentrates as far as possible on the water-bath. The residual mass is extracted with alcohol to which one-third its volume of ether has been added (until a few drops of the filtrate give not a deep blue solution, but a pale blue precipitate with copper sulphate and potassa free from carbonic acid), the solution is evaporated, the residue dried at 115°, weighed, incinerated, and the weight of the ash deducted.

Determination of the Total Carbon in Crude Iron and Steel.—H. F. Starr.—This method is not new.

Determination of Alkaloids in Nux Vomica.—W. R. Dunstan and F. W. Short.—From the *Pharmaceutical Journal*.

Sodium Nitro-prusside as a Reagent for Kreatinine and Acetone in Urine.—F. Hofmeister.—Solutions of kreatinine, if mixed with a weak aqueous solution of sodium nitro-prusside and soda, give a more or less intense red colouration, which on the addition of an acid passes into a greenish yellow. The ordinary ingredients of urine do not interfere, but acetone gives a similar change of colour. Indol gives also a brownish red colour, but on the addition of acetic acid it changes to a fine azure blue. Acetone should be sought for in the distillate of urine.

Conjugated Phosphoric Acid in Urine.—MM. Lépine and Eymonnet.—The authors precipitate with magnesia mixture, evaporate the filtrate to dryness, and fuse the residue with saltpetre. In the nitric solution of the melt the newly-formed phosphoric acid is determined by the ordinary procedures. It is probably derived from phospho-glyceric acid.

Oxy-hæmoglobine of the Pig.—J. Otto.—The author gives a method for obtaining this principle from the blood of swine.

The Ptomaines.—MM. Dragendorff and Gräbner.—This paper is not adapted for abstraction.

MISCELLANEOUS.

Appointment.—On Tuesday last, Mr. F. J. M. Page, B.Sc., F.C.S., was elected Demonstrator of Practical Chemistry at the London Hospital Medical College.

British Association for the Advancement of Science.—The following are the names of the Officers and Committee of Section B (Chemical Science) of the Southport Meeting of the British Association:—

President.—J. H. Gladstone, Ph.D., F.R.S.

Vice-Presidents.—Prof. J. Dewar, M.A., F.R.S.; A. G. Vernon Harcourt, M.A., F.R.S.; Prof. G. D. Liveing,

M.A., F.R.S.; Prof. H. E. Roscoe, Ph.D., LL.D., F.R.S.; W. Weldon, F.R.S.; Prof. A. W. Williamson, Ph.D., LL.D., F.R.S.

Secretaries.—Prof. P. P. Bedson, D.Sc. (Recorder); H. B. Dixon, M.A.; H. Forster Morley, M.A., D.Sc.

Committee.—A. H. Allen; Prof. J. Attfield, F.R.S.; W. Lant Carpenter, B.A., B.Sc.; T. Fairley; R. Meldola; E. K. Muspratt; Prof. Chandler Roberts, F.R.S.; G. Ward; Prof. W. Carleton Williams; C. R. A. Wright, D.Sc., F.R.S.

The Papers brought before the Section were as follows:—
Profs. Liveing and Dewar—On Sun Spots and the Chemical Elements in the Sun.

R. Meldola—Colouring matters of the Diazo-group.

Prof. R. B. Warder—Suggestion for computing the Speed of Chemical Reaction.

T. M. Morgan, B.Sc.—Ortho-amido-cinnamic Acid.

T. M. Morgan, B.Sc.—On the Preparation of Cinnamic Acid.

P. M. Parsons—On Manganese Bronze.

H. B. Dixon—Report of Committee on Chemical Nomenclature.

Prof. W. N. Hartley—Report of Committee on the Ultra-violet Spark-spectra.

H. B. Dixon—Explosion of Carbonic Oxide Gas.—A Demonstration.

Prof. A. W. Williamson—Chemical views on the Constitution of Matter.

Prof. Dewar and A. Scott—On the Atomic Weight of Manganese, and the Molecular Weights of the Compound Ammonias.

Dr. J. H. Gladstone—The Length of the Prismatic Spectrum as a Test of Chemical Purity.

Prof. W. Ramsay—The Application of Bisulphide of Carbon to the Scouring of Wool.

W. Lant Carpenter—The Conversion of Oleic Acid into Palmitic Acid, and Fusions with Caustic Alkalies at High Temperatures.

Rev. W. A. Irving—The Action of Sunlight on Phosphorus Trioxide.

Prof. Dewar—On Liquid Marsh Gas.

Prof. Dewar—On Critical Points and Pressures and their relation to Atomic Volumes.

G. Johnstone Stoney—On the relation between Chemical Constitution and Crystalline Form.

Dr. J. H. Gladstone and A. H. Tribe—The Electrolysis of dilute Sulphuric Acid in Secondary Batteries.

Prof. W. Chandler Roberts—Mobility of Gold and Silver in molten Lead.

E. C. C. Stanford—Algine, a new substance obtained from sea weed.

Watson Smith—Processes for the coking of coal with recovery of the bye-products.

Prof. H. E. Armstrong—Report on Isomeric Naphthalene derivatives.

H. Brereton Baker—On the alleged direct union of Hydrogen and Nitrogen.

Profs. Friedel and Crafts—Decomposition of Hydrocarbons by means of Aluminium Chloride.

R. Warington—On the Nitrates in Soil.

M. Whitley Williams—A description of a simplified Thermostat.

M. Whitley Williams—An account of some experiments on Asbestos.

J. A. Wanklyn and A. Fox—On the constitution of natural fats.

J. A. Wanklyn—On the employment of limed coal in gas-making.

W. Thomson—On methods of demonstrating that transparent glass is crystalline.

W. Thomson—On molecular movements in the vicinity of thin iron plates.

W. Lant Carpenter—On the teaching of Chemistry in Elementary Schools.

J. Boyd Kinnear—New method for Disinfecting Sewage, and recovering Ammonia from it.

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ON A REACTION BETWEEN MERCURIC CYANIDE AND SILVER NITRATE IN THE PRESENCE OF AMMONIA.

By C. L. BLOXAM.

ALTHOUGH ammonia does not precipitate a solution of mercuric cyanide or silver nitrate when separate, a mixture of the two solutions gives a copious opaque precipitate with ammonia.

A salt having the formula $\text{AgNO}_3, \text{HgCy}_2, 2\text{Aq}$, was obtained by Wöhler, and is described in "Gmelin's Handbook" (viii., 33), where it is stated that "alkalies throw down cyanide of silver," but if the formula represent the salt correctly, it is not intelligible that this should be the case.

On mixing solutions of the two salts which are neutral to blue litmus, the mixture is found distinctly acid, indicating the production of mercuric nitrate, which has an acid reaction. If the solutions are moderately strong, the mixture presents an excellent instance of supersaturation, remaining clear until stirred with a glass rod, when it becomes a pasty mass of fine needles. Under the microscope the sudden crystallisation when touched with a glass rod presents a very beautiful appearance. The double salt is remarkable for forming tufts of needles radiating from a centre, and deposited first in sharp thin lines, gradually developing from the end next the centre of the tuft into thick brilliant prisms resembling nitre.

A solution of mercuric nitrate (prepared by decomposing mercuric chloride with silver nitrate) dissolves precipitated silver cyanide very readily on warming, and deposits the characteristic needles of the double salt on cooling. The same result was obtained with the solution of (so-called) basic mercuric nitrate prepared by saturating diluted nitric acid with mercuric oxide. Synthesis, therefore, is not opposed to the view that the salt contains mercuric nitrate and silver cyanide. On the other hand, hydrocyanic acid precipitates silver cyanide from the aqueous solution of the salt, indicating the presence of silver nitrate. The salt, which had been well pressed in filter-paper, lost 8.29 per cent at 100°. The formula requires 7.86. Wöhler gives 7.6, and Johnstone (by difference) 7.93.

A strong solution of silver nitrate was treated with dilute ammonia till the precipitate was just re-dissolved. Solution of mercuric cyanide was then added by degrees, with constant stirring. Much ammonia was set free, and an opaque white precipitate (A) was produced. After a certain quantity of mercuric cyanide had been added, a silky crystalline precipitate separated; this portion (B) was collected apart. The filtrate gave another silky precipitate (C) of somewhat different appearance. The filtrate from this contained a very small quantity of silver, but much mercury and cyanogen. Precipitate A decomposed with a slight explosion when heated. Qualitative analysis indicated much silver, mercury, and cyanogen, with a little nitric acid and ammonia.

After a week's exposure to air dried by sulphuric acid, it was found to lose 0.82 per cent when heated to 100°. The salt having become slightly discoloured, this loss is probably due to decomposition, and the salt is anhydrous.

14.6 grains treated with strong hydrochloric acid, evolved much HCN, and, after evaporation and fusion, left 8.72 of silver chloride, giving 44.93 per cent of silver.

22.78 grains, decomposed by hydrochloric acid, the silver chloride washed with hot water, the mercury in the filtrate

precipitated by H_2S , gave 36.72 per cent of mercury, and 44.79 per cent of silver.

18.60 grains, treated in the same way, gave 45.23 per cent of silver and 36.13 per cent of mercury, the silver chloride having retained some of the mercuric chloride.

14.57 grains were distilled with a strong solution of potash into a receiver containing HCl. The ammonium chloride obtained weighed 0.15, corresponding to 0.32 per cent of ammonia, which is probably carried down by the precipitate and not essential to its composition.

10.57 grains digested with yellow ammonium sulphide, to convert the cyanogen into ammonium sulphocyanide, the filtrate evaporated, mixed with silver nitrate and excess of nitric acid, gave a precipitate which, when strongly ignited, gave 6.13 grains silver, corresponding to 13.95 per cent of cyanogen.

Finding that the decomposition of the salt by potash was incomplete, since the residue of mixed oxides deflagrated when heated, a portion was digested with KHS and sulphur, with a view to the determination of the nitric acid. After being heated till no more ammonium sulphide was evolved, the solution was filtered from the sulphides of silver and mercury, mixed with caustic potash, and allowed to remain for about twenty hours in contact with sheet aluminium in a retort connected with a receiver containing hydrochloric acid, into which it was eventually distilled; the distillate gave 0.34 grain of ammonium chloride, corresponding to 0.394 of NO_3 or 2.11 per cent, which appears to me too small a quantity to be regarded as an essential constituent.

Precipitate B exploded somewhat less violently than A. After being dried over sulphuric acid, it lost only 1.13 per cent at 100°. Analysed in the same manner as A, it gave in two determinations, 45.54 and 45.68 per cent of silver, and 36.08 and 36.29 per cent of mercury, showing that its composition was the same as that of A.

If the NH_3 and NO_3 be regarded as impurities carried down by the precipitate, and their sum be deducted from the weight of the precipitate, the results agree closely with those required by the formula $2\text{HgO}.\text{HgCy}_2.7\text{AgCy}$:-

	Calculated.	Found.
Ag ₇	46.60	46.43
Hg ₃	36.99	37.03
Cy ₉	14.42	14.29

It would be more satisfactory to determine the cyanogen by another method before finally accepting the formula; this I am prevented from doing at present by the termination of my vacation.

Precipitate C was silver cyanide. When decomposed by hydrochloric acid it gave AgCl corresponding to 79.71 per cent of silver; the pure cyanide contains 80.6. The filtrate gave a dark tinge, but no precipitate, with H_2S .

The above experiments appear to me to justify the belief that mercuric cyanide and silver nitrate undergo, at least partially, a mutual decomposition into silver cyanide and mercuric nitrate, and that the precipitate formed in the presence of ammonia is composed of silver cyanide and mercuric oxycyanide.

King's College, London.
Sept. 25th, 1883.

Enrichment of the Soil in Nitrogen.—M. Agathon. —In 1868, a certain portion of the experimental fields at Grignon, was found to contain 2.02 to 2.04 grms. nitrogen per kilo. In the years 1870 to 1882 inclusive, it produced 4 crops of wheat, 2 of oats, 1 of tares and peas, 1 of beets, and 4 (continuously) of lucerne, receiving as manure 104,000 kilos. farm yard manure. The total crops had certainly removed more nitrogen than this quantity of manure could compensate, yet, in the autumn of 1882, the soil was found to contain 2.45 to 2.56 grms. nitrogen per kilo. The author ascribes this enrichment to the four years' cropping with lucerne.—*Biedermann's Centralblatt*.

PROFESSOR HOFMANN'S ADDRESS AT THE
UNVEILING OF THE LIEBIG MEMORIAL
AT MUNICH, AUGUST 6th.

AFTER a few introductory remarks, Professor Hofmann went on to say:—

"Let us, though with hurried steps, retrace the course of Liebig's life: the outward incidents of a life devoted to Science are soon told. Justus Liebig was born on May 13, 1803, in Darmstadt; his parents were of the middle class, his father being a dyer and cloth merchant, and it was without doubt the many opportunities the boy enjoyed in his father's factory of watching the processes of dyeing that early gave him an interest in Chemistry; at least, we find him, at an age at which few have decided on or even thought of their like-work, zealously devoting himself to the preliminary studies of that science which was soon to occupy his whole attention. At that time chemistry held by no means the prominent position in our universities that it does to-day; we must therefore not be surprised that, after a brief residence at Bonn and Erlangen, Liebig turned his eyes to Paris, at that time the centre of attraction to disciples of science. By a happy combination of circumstances Liebig's wish to continue his studies under the famed masters of the French capital was quickly gratified. The spirit of discovery was early roused in him, and the first-fruits were such as showed that he possessed exceptional talents in that direction. Although through the generosity of the then Grand Duke of Hesse his stay in Paris was prolonged, still his dearest wish would have been unfulfilled had he not fortunately made the acquaintance of Alexander von Humboldt, through whose powerful influence the doors of the French laboratories were opened to the young chemist as if by a magic wand. With his usual keen insight the famous German explorer recognised at once the great promise of his young fellow-countryman, and from that hour was his protecting friend: quickly his *protégé* gave proof how justly that protection was bestowed.

At the commencement of the century Howard and Brugnatelli had discovered these explosive compounds of mercury and other metals, which are still used in percussion caps and for similar purposes. The chemical composition of these compounds was at that time unknown, as chemists had been deterred from examining them by several serious explosions; but, in conjunction with Gay-Lussac, in whose laboratory he was working, Liebig undertook their investigation, and succeeded at length in ascertaining the nature of these mysterious bodies, with the result of placing the chemistry of explosives on a firmer foundation, and opening up new fields of research.

This work, accomplished under the auspices of Gay-Lussac, won for Liebig an established place in Science; but it had another result, which he never ceased to regard as the most fortunate event of his life. Shortly after Liebig's research was published, Frederick Wöhler, a young chemist of nearly the same age, arrived at results in an allied branch of investigation, which he believed to be at variance with those of Liebig. The consequence was a keen controversy, in which Liebig was beaten. This encounter in the same field of work—to smaller souls so oft a source of bitterness or lasting hate—only drew these young men together, and formed the commencement of a life-long friendship, which proved a source of pleasure to themselves and of the richest service to science. After remaining in Paris for two years, Liebig returned to Germany, where, on the recommendation of Humboldt, he was, at the age of 23, appointed first extraordinary, and soon after ordinary, Professor of Chemistry at Giessen. It was there, in the small University town on the banks of the Lahn, that Liebig earned his world-wide fame.

In order to understand aright Liebig's triumphs in discovery, we must go back to the third decade of the century. Thanks to the pioneer work of Lavoisier and his contemporaries at the end of last century, and to the

comprehensive researches of Berzelius in Sweden, Davy in England, and Gay-Lussac in France, at the beginning of the present, chemistry had acquired a philosophic foundation: what was known in this connection was due almost exclusively to the study of inorganic substances. Then for the first time attention was directed to the constituents of animal and vegetable products; thus a wide field of investigation was opened up, which Liebig was not slow to take possession of. His efforts were rewarded by a long series of brilliant results, which enrich the history of organic chemistry: some achieved by himself alone, others along with his friend Wöhler, or with the assistance of enthusiastic disciples, who were not slow to enrol themselves under the banner of the Great Master. The extensive field was explored in all directions; no corner, however remote or obscure, escaped the keen glance of the untiring explorer.

I might here endeavour to enumerate the results of Liebig's researches in the province of organic chemistry, and show their many-sidedness and number; give you examples of the acuteness and accuracy of his observations; his unprejudiced interpretation of the results obtained; the forcible logical sequence of his experiments, and the finely-forged chain of his evidence: in this connection I would naturally also show to you the manner in which the separate experiments are woven into one great scheme, in which it would not be difficult to recognise the basis on which, by the united work of investigators of all lands, the glorious superstructure of modern organic chemistry has been raised: but such a detailed account of Liebig's life-work would require hours instead of the few minutes at my disposal. I am therefore in a position only to sketch its principal features in brief outline.

To the conqueror who has won for us a new province of science belongs our greatest admiration, but, in addition, deep-felt gratitude is aroused when we find that he has supplied us also with weapons wherewith we hope not merely to retain possession of his conquest, but also to make new ones for ourselves. This Liebig has done. Not content himself to question Nature, he has put others in a position to do the same, making it his constant endeavour to simplify and perfect the means of doing so. It is to him we owe these efficacious methods for the analysis of organic substances, which are still in constant use, and seem likely for all time to meet the requirements of experimenters. Thus the fame of Liebig is assured, for, although his own short work-day is over, he still lives on, taking part in the work of his successors and sharing their triumphs.

While speaking of the important aids to research with which he has enriched science, we naturally call to mind that he was the first to give methodical instruction in the art of investigation. The experimental method of teaching which is to-day practised with such brilliant results in our German universities, is in form and essence the same as that which Liebig introduced more than half a century ago; and though we now possess appliances far superior to those at Liebig's disposal, we must not forget that these splendid temples of science which to-day form part of all our schools, have as their prototype that modest laboratory which he founded on the Lahn, and to which he for many years attracted the flower of the chemists of all lands.

Had the history of chemistry no other service of Liebig to chronicle than that he had thus assisted her growth, his name would still be inscribed on its pages in golden letters. Our fatherland has had at all times many distinguished men whose services to science it has always been ready to recognise, and we would not be standing to-day on the steps of Liebig's memorial had he not done so much to enlarge the bounds of chemistry. It was a distinctive trait in his character that he, though a student of pure science, still found his greatest satisfaction in being able to utilise his discoveries for the purposes of practical life. Thus it came to pass that his scientific work included a number of branches of industry based on

chemical principles. That portion relating to explosives has been already referred to; in a similar way his investigations on *Fats*, Acetic Acid, and Potassium Ferrocyanide, have had beneficial results. Lastly, the method proposed by him for the preparation of potassium cyanide, so largely employed in electro-plating, has had an indirect, but still an unmistakable, influence on the development of that industry.

However important may have been the influence of Liebig's researches on the above industries, it sinks into insignificance before the results of his work in two branches of study which appeal to the sympathy of all men. In the book which the genius on the pedestal before you holds in his hand we find inscribed after chemistry, agriculture and physiology. It is indeed in the department of agriculture that Liebig has done most for the welfare of his fellow-men, and it may well surprise us that it was reserved for the youngest of the sciences to effect, in the oldest of all industries, reforms,—nay, well-nigh a complete revolution,—and that this should be accomplished by one who had never walked behind a plough, nor possessed a single acre. For thousands of years had men sown and reaped without gaining any clear knowledge of the laws of the growth of plants. Experience, it is true, left no doubt as to the efficacy of manure, but with regard to the part it played in nourishing the plant the most daring hypotheses were common. It is only with difficulty that we can now realise the condition of agriculture when Liebig first attacked its problems from their chemical side. Inasmuch as he has made known the true nature of vegetable life, and the real action of manures, he has given the farmer the key to the most difficult problems. Scales fell from his eyes when he realised what constituents of the growing plant came from the air, and what from the soil, and in what way the loss to the soil must be repaired if he would retain the fertility of his fields. Here the question presented itself, Was this reparation to be made only by animal manure? and the answer came most clearly and decisively in the wide development of the various artificial manure industries. The manufacture of chemical substitutes for animal manure, which in a short time assumed enormous proportions, is thus entirely the result of Liebig's work. Thus agriculture, no longer to be classed as an art, entered the circle of the sciences, and it is one of Liebig's most powerful claims to fame that he inaugurated a new era in her history.

The food of animals is in the last instance the plant, and since the end of all husbandry is the feeding of the animal, it was only natural that he who had laid bare the development of the plant should also investigate the changes the plant undergoes in the body of the animal. Such a research promised success only to him who succeeded in bringing into the field of discussion all the conditions of animal life. This giant task had no terrors for Liebig's untiring energy, and we have to thank his acuteness and perseverance for a series of investigations on the constituents of the bodies of animals and the processes which take place in them—such as no other chemist can boast of.

His researches proved what formerly was a matter of conjecture, that the body of the animal is fore-prepared in the plant. The dependence of animal life on plant life is no longer doubtful, and the true appreciation of the life-conditions of animals and plants in their mutual relations enables us to recognise the course of nature in all its admirable simplicity. The expert calls to mind Liebig's long-continued researches on the food change in animals; on the formation of flesh and fat; on the functions of the different food materials which allowed him to divide them into "*plastische und respiratorische nahrung*": and if much to-day appears different to physiologists than it did to the investigator, who a quarter of a century ago first let a flood of chemical light into the darkness which hid the processes of life from view, still all, even those who have extended and improved his

views, readily and cheerfully admit that they are, so to speak, standing on his shoulders. Just as Liebig's researches on plants proved of service to man far beyond the narrow bounds of science, so his studies in animal chemistry at once were turned to meet the requirements of life. In fact, scarcely had Liebig by his comprehensive research on flesh devised a simple process for separating and preserving the valuable constituents of meat, than a new industry sprang up with the object of turning to practical account this new achievement of science: and now for many years Europe has enjoyed the rich stores of food existing in another hemisphere, and this form of food has in a short space of time spread itself over the world, and attained a universal distribution similar to that of tea and coffee. Need I remind you also how Liebig, by his investigations on milk, was roused to the endeavour to provide a substitute for human milk, and so to render good service to the coming generations?

Liebig was now at the height of his fame, but his life was to undergo a change which turned his activity in a new direction. At this time Maximilian II. set himself the task of raising to the proud position of the centre of German science this town (Munich), which for many generations had been the home of German Art. One of the first appointments that was made was Liebig's. From the list of famous men collected on the Isar, his name could not be spared; but he was not easily moved. He clung lovingly to the low position in which he had accomplished such great things; but the personal wish of the King effected what the high station alone failed to do.

In this assembly it is hardly necessary to point out the comprehensive activity of Liebig in his new position, and the influence he exercised on the development of education, agriculture, and various industries; how he, as formerly, surrounded himself with an enthusiastic circle of disciples, and with his own hands created the famous School of Chemistry, which at this time flourishes in Munich under his worthy successor. It would ill become a stranger to speak here of Liebig's Munich days; let me, however, add that he never ceased to congratulate himself on being in a position to spend so happily the close of his life.

I must, before finishing the memorial wreath which I have to lay on the steps of his monument, interweave a few leaves bearing on the noble character of the man, but it is with considerable hesitation that I do so in the presence of so many who can boast of personal intercourse with Liebig up to the day of his death. Even, however, to me who must go back a quarter of a century to the time I spent in Liebig's neighbourhood, the memory of his noble character comes back with irresistible force.

Mind and soul strove in his happily balanced nature for the front rank; no sooner was one roused to admiration by his keen intellect, than the next moment one's deepest feelings were stirred by the heart of the man beating for all that was great and good. Happy the friend who had cast anchor in that deep heart! How Liebig regarded friendship has been recently told us by Wöhler, the companion of his youth. How many of us have experienced his steady fidelity to his friends, his never-tiring sympathy, his cheerful helpfulness! What a friend Liebig was has not reached the ears of the world, but the recollection lies hid in many thankful hearts. As in great things, so in small. The same noble principles which had served as his guides in investigation—his incorruptible love of truth—his unerring judgment—the same noble traits that rejoiced his friends—the nobleness of his thoughts—his active goodness of heart and his modest benevolence—were to be found also in his quiet everyday intercourse with his fellow-men. Hence came the irresistible charm which Liebig possessed on all sides.

He who dwells on this rich life finds fit expression for his thoughts in Hamlet's words—

He was a man, take him for all in all,
I shall not look upon his like again.

INCOMBUSTIBLE PAPER AND COLOURS.

At the Séance of the Société d'Encouragement pour l'Industrie Nationale on the 27th July of this year, M. G. Meyer submitted to the examination of the Society the results of his new experiments with his incombustible paper and colours. The admirable manner in which these materials could resist a high temperature was illustrated by rolls of the paper, printed with diverse colours; one half of the roll having been exposed for four hours to the heat of a muffle furnace. On a comparison of the two halves, that which had been subjected to the heat of the furnace had lost nothing of its flexibility, or the colours of their brilliancy.

The value of this invention of M. Meyer's has the advantage that the materials cost not much more than the paper, colours, ink, &c., generally employed, so that important documents, scenery for theatres, and wall-paper may be made, so as to resist a heat sufficient to melt glass, almost as cheaply as the articles now employed.

A sample of this paper with a printed design, which we have had the pleasure of examining, heated for a short time to redness in an air-gas burner, the design appeared almost as bright as before the operation, with but a slight alteration of the texture of the paper, and no loss of flexibility or toughness.

SEPARATION OF GALLIUM FROM TITANIUM.

By LECOQ DE BOISBAUDRAN.

THE author indicates five methods, of which the one most generally applicable is founded upon the action of boiling potassa.

1. The titano-gallic solution is treated with a small excess of potassa and boiled for some minutes. The flocky precipitate collects quickly and filters without difficulty; after washing with slightly alkaline water it retains merely small traces of gallium, which are removed by re-dissolving in the cold with dilute hydrochloric acid, and repeating the treatment with potassa. The process succeeds equally well if we set out either with the product of the solution of titanium tetrachloride in dilute hydrochloric acid, or with the liquid obtained on dissolving in dilute hydrochloric or sulphuric acid, titanic acid previously precipitated by potassa, or, lastly, from a sulphate soluble in the cold, the result of treating the titanic compounds with boiling sulphuric acid or melting ammonium bisulphate.

2. The galliferous titanic acid is heated with sulphuric acid. The mass, when cold, is dissolved in an excess of water, and then boiled. The precipitate contains the greater part of the titanic acid, though a notable part remains in the solution. This is evaporated until the greater part of the sulphuric acid is expelled, though a little of this acid should remain in the free state. It is let cool, re-dissolved in water and boiled again. The matter resolves itself gradually into two fractions: A, the precipitate containing almost all the titanium and slight traces of gallium; B, the liquid containing the gallium with a little titanium. A is re-dissolved in hot sulphuric acid and the solution treated as has just been described, when the traces of gallium are easily removed. But the liquid B retains still a small quantity of titanic acid, because the expulsion of the free sulphuric acid cannot be carried beyond a certain limit without risking the formation of gallium sub-sulphate on boiling the dilute liquid. It is true that much of this gallium sub-sulphate re-dissolves during the cooling of the unfiltered liquid. The more or less complete precipitation of the titanic acid depends on the proportion of gallium oxide contained in the mixture. The last portions of the titanic acid are removed by potassa according to the di-

rections given under method 1. In spite of this little analytical complication, the precipitation of titanium by boiling very dilute solutions may serve if only to concentrate rapidly in a small bulk small quantities of gallium mixed with much titanium. If the matter to be analysed is not readily attacked by boiling sulphuric acid it is fused with ammonium bisulphate. The product of this operation is taken up in water, boiled after the addition of aqua regia in order to destroy ammoniacal salts, and then boiled until sulphuric vapours appear. The remaining treatment is then the same as described above.

3. The hydrochloric or sulphuric solution of galliferous titanic acid is mixed with arsenious acid and an excess of acid ammonium acetate. The liquid is treated with hydrogen sulphide immediately after the introduction of the ammonium acetate. Sometimes it happens that titanic acid is spontaneously precipitated by degrees in the acetic liquid. The galliferous arsenic sulphide is treated as directed. (*Comptes Rendus* August, 1883, p. 522). We rarely obtain thus at the outset a salt of gallium absolutely free from titanic acid, but the titaniferous gallium may be converted into sulphate and the same method applied again.

4. Tartaric acid and a salt of manganese are introduced into the hydrochloric or sulphuric solution of the titanogallic compound; it is supersaturated with ammonia, and ammonium sulphate is added. The galliferous manganese sulphide is very carefully washed, and then treated as laid down. (*Comptes Rendus*, June, 1882, p. 1626.) This method is especially applicable to the extraction of traces of gallium mixed with large quantities of titanic acid.

5. When the titano-gallium mixture is in a hydrochloric solution it may be evaporated to dryness, raising the temperature finally to 120°, and treating the residue in heat with dilute hydrochloric acid. There remain along with the titanic acid mere traces of gallium, which may be neglected in an ordinary analysis. In an exact determination the residue of titanic acid must be attacked with sulphuric acid or ammonium bisulphate, and the traces of gallium extracted by means of one of the other methods.

Titanic acid, obtained by evaporating its hydrochloric solution, passes easily through ordinary filters. The solution can be obtained clear only by dissolving in it ammonium hydrochlorate and making use of a very compact filter.—*Comptes Rendus*.

INSOLUBLE PHOSPHATES.

By FREDERICK JAS. LLOYD, F.C.S.

IN the analysis of superphosphates it is customary to estimate with the greatest care the phosphoric acid soluble in water, but all the remaining phosphates are classed as "insoluble." This method, besides taking no notice of the existence of precipitated or retrograde phosphates, disregards the exact composition of these insoluble phosphates, and the part they would play as manures.

The usual method of estimating "insoluble phosphates" is as follows:—After washing out the soluble phosphate from a given quantity of the manure, the remainder is burnt, dissolved in hydrochloric acid, the insoluble silica filtered off, and the filtrate made ammoniacal. The precipitate thrown down is collected, washed, burnt, and weighed, and receives the indefinite term "insoluble phosphates." The insoluble phosphates thus obtained are easily divided into two classes, those which after burning are "white," and those which are "red."

During the last five years, while acting as assistant chemist at the Royal Agricultural Society, I performed a great number of such analyses, collected these precipitates separately, and have recently investigated them.

The "white" precipitates are only obtained from manures made with bones, and represent approximately the amount of bone phosphate left undissolved, though it

does not attempt to, nor does it, show the exact state in which these phosphates exist. That they are not in the form of bone phosphate, I have ample evidence to prove.*

Being anxious to know the real composition of the "red" insoluble phosphates, and having collected 17 grms. of these precipitates, which would represent far more than 100 samples analysed, their composition was carefully determined, with the following results:—

Composition of "Red" Insoluble Phosphates.

Lime	32.53
Oxide of iron	31.80
Phosphoric acid	35.77

100.10

I was somewhat surprised at being unable to obtain any estimable quantity of alumina. If there had been sufficient quantity of lime present to combine with the whole of the phosphoric acid, these insoluble phosphates would have contained 78 per cent of phosphate of lime, or only a little more than three-quarters the quantity of phosphate they are supposed to represent. But they contain neither enough lime nor enough iron to combine alone with the phosphoric acid, though together these are more than sufficient. Hence one of these must be present in the state of oxide. The only probable assumption is that the iron exists partly as oxide, and that the exact composition of the "red" insoluble phosphates is—

Phosphate of lime	60.01
Phosphate of iron	17.63
Oxide of iron	22.46

100.10

Thus it is seen that these red insoluble phosphates contain only 60 per cent of phosphate of lime instead of 100.

The manifest error which the present method of estimating insoluble phosphates entails makes it a subject of importance alike to agriculturists and to chemical manure manufacturers. The present estimated value of insoluble phosphates is 2s. per unit, and in buying manures by guarantee the farmer pays this sum for every unit of so-called "insoluble phosphates," whether he receive for his money really bone phosphate, or whether he is simply paying for oxide of iron. The manure manufacturer is equally unfairly treated, for how can the manufacturer who puts bone in his manure compete with the manufacturer whose manure contains mineral matters rich in iron, which iron is in the analysis put down as of equal value to bones. The error is detrimental to all parties alike. It is a subject which those who have the interest of the farmers at heart should enquire into, and it might be well for the recently-formed chemical section of the London Chamber of Commerce to take some steps in the matter.

A few experiments were made in the endeavour to get rid of the error without at the same time entailing on the analyst the necessity of the usual tedious estimation of phosphoric acid, but as these experiments did not succeed they do not require enumerating.

Laboratory,
49, Bloemfontein, Shepherd's Bush,
London, W.

The Cause of the Decrease of Tartar in Plastered Wines.—P. Pichard.—The author considers that the cause is not a decomposition of the tartar, but on its reduced solubility in presence of a certain quantity of potassium sulphate. The author utilises this property for determining potassium bitartrate. Free tartaric acid interferes with this process, which is inapplicable in case of plastered wines. Malic and succinic acids do not interfere.—*Biedermann's Centralblatt*.

* See "Retrograde Phosphates," *Chem. Soc. Journal*, 1882, p. 314.

A RECALCULATION
OF
THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.
Chief Chemist to the U.S. Geological Survey, Washington.

CALCIUM.

FOR determining the atomic weight of calcium we have sets of experiments by Berzelius, Erdmann and Marchand, and Dumas. Salvétat† also has published an estimation but without the details necessary to enable us to make use of his results. I also find a reference‡ to some work of Marignac; which, however, seems to have been of but little importance. The earlier work of Berzelius was very inexact as regards calcium, and it is not until we come down to the year 1842 that we find any material of decided value.

The most important factor in our present discussion is the composition of calcium carbonate, as worked out by Dumas and by Erdmann and Marchand.

In 1842 Dumas|| made three ignitions of Iceland spar, and determined the percentages of carbon dioxide driven off and of lime remaining. The impurities of the material were also determined, the correction for them applied, and the weighings reduced to a vacuum standard. The percentage of lime came out as follows:—

56.12
56.04
56.06

Mean 56.073 ± 0.016

About this same time Erdmann and Marchand§ began their researches upon the same subject. Two ignitions of spar, containing 0.04 per cent. of impurity, gave respectively 56.09 and 56.18 per cent. of residue; but these results are not exact enough for us to consider further. Four other results obtained with artificial calcium carbonate are more noteworthy. The carbonate was precipitated from a solution of pure calcium chloride by ammonium carbonate, was washed thoroughly with hot water, and dried at a temperature of 180°. With this preparation the following residues of lime were obtained:—

56.03
55.98
56.00
55.99

Mean 56.00 ± 0.007

It was subsequently shown by Berzelius that calcium carbonate prepared by this method retains traces of water even at 200 degrees, and that minute quantities of chloride are also held by it. These sources of error are, however, in opposite directions, since one would tend to diminish and the other to increase the weight of residue.

In the same paper there are also two direct estimations of carbonic acid in pure Iceland spar, which correspond to the following percentages of lime:—

56.00
56.02

Mean 56.01 ± 0.007

In a still later paper¶ the same investigators give another series of results based upon the ignition of Iceland spar. The impurities were carefully estimated, and the percentages of lime are suitably corrected:—

* Smithsonian Miscellaneous Collections. "The Constants of Nature."

† *Comptes Rendus*, 17, 318. 1843.

‡ See Oudemans' Monograph, p. 51.

|| *Comptes Rendus*, 14, 537. 1842.

§ *Journ. f. Prakt. Chem.*, 26, 472. 1842.

¶ *Journ. f. Prakt. Chem.*, 31, 269. 1844.

4.2134 grms. CaCO_3 gave	2.3594	CaO .	55.997	per cent.
15.1385	8.4810	"	56.022	"
23.5503	13.1958	"	56.031	"
23.6390	13.2456	"	56.032	"
42.0295	23.5533	"	56.044	"
49.7007	27.8536	"	56.042	"

Mean 56.028 ± 0.0047

Six years later Erdmann and Marchand* published one more result upon the ignition of calcium carbonate. They found that the compound began giving off carbon dioxide below the temperature at which their previous samples had been dried, or about 200° , and that, on the other hand, traces of the dioxide were retained by the lime after ignition. These two errors do not compensate each other, since both tend to raise the percentage of lime. In the one experiment now under consideration these errors were accurately estimated, and the needful corrections were applied to the final result. The percentage of residual lime in this case came out 55.998. This agrees tolerably well with the figures found in the direct estimation of carbonic acid, and, if combined with those two, gives a mean for all three of 56.006 ± 0.0043 .

Combining all these series we get the following result:—

Dumas	56.073	± 0.016
Erdmann and Marchand	56.006	0.007
"	56.028	0.0047
"	56.006	0.0043

General mean.. 56.0198 ± 0.0029

For reasons given above this mean is probably vitiated by a slight constant error, which makes the figure a trifle too high.

In the earliest of three papers by Erdmann and Marchand there is also given a series of determinations of the ratio between calcium carbonate and sulphate. Pure Iceland spar was carefully converted into calcium sulphate, and the gain in weight noted. 100 parts of spar gave of sulphate:—

136.07
136.06
136.02
136.06

Mean 136.0525 ± 0.0071

In 1843 the atomic weight of calcium was re-determined by Berzelius,† who investigated the ratio between lime and calcium sulphate. The calcium was first precipitated from a pure solution of nitrate by means of ammonium carbonate, and the thoroughly washed precipitate was dried and strongly ignited in order to obtain lime wholly free from extraneous matter. This lime was then, with suitable precautions, treated with sulphuric acid, and the resulting sulphate was weighed. Correction was applied for the trace of solid impurity contained in the acid, but not for the weighing in air. The figures in the last column represent the percentage of weight gained by the lime upon conversion into sulphate:—

1.80425 grms. CaO gained	2.56735	grms.	142.295
2.50400	3.57050	"	142.592
3.90000	5.55140	"	142.343
3.04250	4.32650	"	142.202
3.45900	4.93140	"	142.567

Mean 142.3998 ± 0.0518

Last of all we have the ratio between calcium chloride and silver as determined by Dumas.‡ Pure calcium chloride was first ignited in a stream of dry hydrochloric acid, and the solution of this salt was afterwards titrated with a silver solution in the usual way. The CaCl_2 proportional to 100 parts of Ag is given in a third column:—

2.738 grms. $\text{CaCl}_2 =$	5.309	grms. Ag.	51.573
2.436	4.731	"	51.490
1.859	3.617	"	51.396
2.771	5.3885	"	51.424
2.240	4.3585	"	51.394

Mean 51.4554 ± 0.0230

We have now four ratios to calculate from, as follows:—

- (1) Per ct. of CaO in CaCO_3 , 56.0198 ± 0.0029
- (2) $\text{CaO} : \text{SO}_3 :: 100 : 142.3998$ 0.0518
- (3) $\text{CaCO}_3 : \text{CaSO}_4 :: 100 : 136.0525$ 0.0071
- (4) $\text{Ag} : \text{CaCl}_2 :: 100 : 51.4554$ 0.0230

These give us the subjoined values for calcium:—

From (1)	$\text{Ca} = 39.955 \pm 0.011$
From (2)	" $= 40.139$ 0.023
From (3)	" $= 39.925$ 0.068
From (4)	" $= 40.069$ 0.058

General mean.. $= 39.990 \pm 0.010$

If $\text{O} = 16$, then $\text{Ca} = 40.082$.

A glance at the above figures will show that if, as is probable, the value deduced from the composition of calcium carbonate is a trifle too high, the general mean must be too high also. It is, therefore, interesting to see what results the very latest of Erdmann and Marchand's experiments will lead to. They found, after taking every precaution, in a single experiment that calcium carbonate yielded 55.998 per cent. of lime. From this we get $\text{Ca} = 39.905$; or, if $\text{O} = 16$, $\text{Ca} = 39.997$. It is possible, then, that "Prout's law" may hold good for calcium.

PAPERS UPON INDUSTRIAL CHEMISTRY.

By Prof. ALBERT R. LEEDS., Ph.D.

A NEW SCHEME FOR THE ANALYSIS OF SOAP.

(1). *Water*.—Weigh out about 5 grms. in very fine, small shavings upon a dried, weighed, plated filter. Dry at 110° until weight is constant. The loss is water.

(2). *Uncombined Fat*.—Transfer the filter containing the dried soap to the funnel connected with the return cooler, such as is used in the determination of the albumenoids in milk, and connect with the funnel a small tared flask, containing 50 c.c. petroleum ether. After complete extraction distil off the ether, and the residue in the flask, dried at 110° , will be the uncombined fat.

(3). *Soap*; (4). *Free Alkali*; (5). *Glycerin*.—Allowing the funnel, with the soap freed from moisture and from fat, to remain on the return cooler, attach to it a flask containing about 75 c.c. of 95 per cent alcohol and extract. To the alcoholic solution add a few drops of phenolphthalein; if free acid be present, neutralise with normal sulphuric acid, and calculate the amount of uncombined soda.

After neutralisation add a large excess of water and boil off the alcohol. To the aqueous solution add a large excess of normal sulphuric acid. Boil, cool, and decant through a small filter, wash with hot water and decant after cooling through the filter until litmus-paper is no longer reddened by the washings. The filtrate consists of the combined soda and glycerin, the residue of the fatty acids and resin.

Neutralise the filtrate with normal soda solution and calculate the amount of combined soda as Na_2O . Evaporate to dryness, and extract the glycerin with absolute alcohol. Transfer the alcoholic solution to a tared flask, distil off the alcohol, dry at 100° , and weigh the residue as glycerin.

Fatty Acids and Resin.—Dissolve the small amount of the fatty acids and resin that may be on the filter through which the decantation was effected with a little petroleum

* *Journ. f. Prakt. Chem.*, 50, 237. 1850

† *Journ. f. Prakt. Chem.*, 31, 263. *Ann. Chem. Pharm.*, 46, 241.

‡ *Ann. Chim. Phys.* (3), 55, 129. 1859. *Ann. Chem. Pharm.*, 113, 34.

DR. LEEDS'S SCHEME FOR SOAP ANALYSIS.

Weigh out 5 grammes. Dry at 110°. Loss corresponds to water.

Treat with petroleum ether.

Residue is soap and mineral constituents. Treat with alcohol.

Extract is uncombined fat. Dry at 110° and weigh.

Extract is soap (fatty anhydride, resin, and combined alkali), glycerin, and free alkali. Add two or three drops of phenol-phthalein. If necessary, titrate with normal sulphuric acid.

Residue.— Na_2CO_3 , NaCl , Na_2SO_4 , sodium silicate, starch, and insoluble residue. Wash with 60 c.c. water.

Filtrate.— Na_2CO_3 , NaCl , Na_2CO_4 , and sodium silicate. Divide into four equal parts.

H_2SO_4 used corresponds to free alkali. Calculate as NaHO .

Add a large excess of water and boil off the alcohol. Decompose with excess of normal H_2SO_4 . Boil, filter, and wash.

Filtrate.—Combined soda and glycerin. Titrate with normal soda solution.

Residue.—Fatty acids and resin. Dry at 110° and weigh. Dissolve an aliquot part in 20 c.c. strong alcohol, and, using phenol-phthalein as an indicator, saponify with soda in slight excess. Boil, cool, and add ether to 100 c.c. Decompose with AgNO_3 by adding in fine powder, and shake well for ten minutes. Allow to settle.

Na_2CO_3 . Titrate with normal H_2SO_4 , and calculate as Na_2CO_3 .

NaCl . Titrate with AgNO_3 or weigh as AgCl . Calculate as NaCl .

Na_2SO_4 . Weigh as BaSO_4 . Calculate to Na_2SO_4 .

Sodium silicate. Decompose with HCl and determine soda combined in silicate and silica.

Residue.—Starch and insoluble residue. Dry the filter and weigh. The weight is the starch and insoluble residue. Starch.—Convert the starch into $\text{C}_6\text{H}_{12}\text{O}_6$. Titrate with Fehling's solution. Subtract the weight of starch found, and the difference is the insoluble mineral constituents.

H_2SO_4 used corresponds to combined soda in soap. Calculate as Na_2O . After titration evaporate to dryness on the water-bath. Treat with absolute alcohol. Evaporate the alcoholic solution to dryness in a tared dish and weigh as glycerin.

Precipitate is stearate, palmirate, and oleate of silver.

Solution.—Resinate of silver. Filter 50 c.c. from the total 100 c.c. Decompose with 20 c.c. HCl (1:2). Allow the AgCl to settle, and evaporate an aliquot part of the ethereal solution in a tared dish. Dry at 110° and weigh. After applying collection for oleic acid, the weight corresponds to the resin. This weight subtracted from the combined weight of fatty acid and resin gives the fatty acids.

ether, add the solution to the larger bulk in the beaker, evaporate off the ether, dry at 100° , and weigh the combined fatty acids. Multiply this result, after subtracting the amount of the resin, by 0.97, and the product is the fatty anhydrides.

(6). *Resin*.—The resin was separated from the fatty acids according to the method proposed by Gladding (*Amer. Chem. Journ.*, vol. iii., p. 416). About 0.5 gm. of the mixture of the fatty acids and resin are dissolved in 20 c.c. of strong alcohol, and with phenol-phthalein as an indicator, soda is run in to a slight supersaturation. The alcoholic solution, after boiling for ten minutes to ensure complete saponification, is mixed with ether in a graduated cylinder till the volume is 100 c.c. To the alcoholic and ethereal solution 1 gm. of very finely powdered AgNO_3 is added, and the contents of the cylinder are shaken thoroughly for ten or fifteen minutes. After the precipitate has settled, 50 c.c. are measured off, and if necessary filtered into a second graduated cylinder. A little more AgNO_3 is added to see if the precipitation is complete, and then 20 c.c. of dilute hydrochloric (1:2) to decompose the silver resinate. An aliquot part of the ethereal solution in the cylinder is evaporated in a tared dish, and weighed as resin, deducting a small correction (for 10 c.c. deduct 0.00235 gm.) for oleic acid. The amount of resin subtracted from the combined weight of fatty acids and resins, as found before, gives the fatty acids.

(7). *Sodic Carbonate*; (8). *Sodic Chloride*; (9). *Sodic Sulphate*; (10). *Sodic Silicate*; (11). *Insoluble Residue*.—The filter in the funnel connected with the return cooler, after treatment with alcohol, contains the mineral constituents of the soap. The contents of the filter are washed with cold water till the washings amount to 60 c.c. The filter is then dried and weighed. The weight gives the insoluble residue and starch.

The starch is converted into $\text{C}_6\text{H}_{12}\text{O}_6$ with dilute acid, and titrated with Fehling's solution. The weight of starch found, subtracted from the total weight of insoluble residue and starch, gives the insoluble mineral constituents.

The aqueous solution of 60 c.c., just mentioned, is divided into four equal parts, in one of which is determined the carbonate of soda, by titration, and in the other parts the chloride, the sulphate, and the silicate respectively, by any convenient method.

and having a length of about 12 c.m. Other dimensions are as shown in the figure, viz., A 45 + 13 m.m., B 40 m.m. in length. A may vary in dimension according to circumstances.

The apparatus is connected together by pulling or pushing the tube B over the tapering end of C after it has been loosely inserted in A. All pressure upon A is thus avoided. The joint is air-tight. When not in use A is slipped over a piece of glass tubing of proper size to protect it from injury. The loop F serves to introduce a slightly hooked glass rod by which A is moved into the combustion-tube or withdrawn from it. The disc D is of platinum foil, perforated, and when in use rests on the end of B within A, and supports the asbestos used in filtration. A small funnel serves to convey liquids to the filtering tube. The filtering tube A with its contents, when dry, is separated from B and C and introduced into the combustion-tube, where it is heated in a current of oxygen as mentioned, in the usual way.



The tube A is easily made in the laboratory, being shaped over a piece of combustion-tubing and soldered with gold leaf. It should fit snugly within the porcelain tube, so that oxygen may pass mainly through the filter and its contents. It is not difficult to find porcelain tube of a proper size to suit the platinum tube, and in case of difficulty the latter can be enlarged by rubbing it with a stout glass rod while held on a piece of combustion-tubing or reduced in size by cutting and re-soldering.

The use of porcelain tubes is of advantage not only because of the high temperature attainable, but also because the average life of such a tube is greater than that of a quantity of glass combustion-tubes costing an equal sum; with the certainty of perfect combustion that is assured in their use, the convenience of seeing the substance under combustion disappears.

The tubes of platinum seem to suffer little in use. One of them has sufficed for about fifty combustions and is still perfectly good.—*Journ. Am. Chem. Soc.*

ON A NEW DEVICE FOR DETERMINATION OF CARBON IN CAST IRON.

By A. A. BRENNEMAN, S.B.

THE carbonaceous residue obtained when cast-iron is dissolved is commonly transferred with the mass of asbestos serving as a filter to the combustion-tube. To avoid accidents incident to this transfer, and to ensure the combustion of refractory portions of graphite, the writer has adopted the modifications of the process described below. A brief note upon the process was read at the meeting of the American Association in 1879, but the success attending its use since then by students under the writer's direction, as well as the introduction of some minor improvements, has led him to believe that a fuller description of the process might be useful to others. The process depends in the main upon the use of combustion-tubes of porcelain, and the employment of a small tube of platinum as a filtering tube, which is subsequently put with its contents into the combustion-tube and heated in a stream of oxygen in presence of cupric oxide in the usual way.

The details of the filtering apparatus will be best understood from the figure.

A is a tube of moderately thick platinum foil, somewhat thicker than that used in blowpipe work, B is a piece of soft rubber tubing fitting snugly within A. C is a piece of glass combustion-tubing, tapered at each end as shown,

CORRESPONDENCE.

VOLUMETRIC ARSENIC.

To the Editor of the Chemical News.

SIR,—My criticism upon Mr. Pearce's method of neutralising the alkaline arseniate solution is unsound. Mr. Low, in an article which appeared in the *CHEMICAL NEWS*, vol. xlviii., p. 85, has clearly demonstrated this fact. Consequently, I retract my statement to the effect that the solution immediately prior to precipitation dare not be alkaline. Had the short article in "Science" been more explicit as regards the rules to be observed in neutralising, this misunderstanding between Mr. Low and myself would never have arisen. In said article there is not so much as a hint that a second neutralisation, after filtering or simply mixing the nitrate of silver and arseniate of sodium, is essential. Mr. Low, however, not only in his own paper, but also in his abstract (?) of one by Mr. Frost, which first appeared in the *Engineering and Mining Journal*, shows plainly that an after neutralisation is occasionally requisite. As regards the possibility of using nitrate of silver and thiocyanate of ammonium in estimating phosphorus, I would observe that the subject has been elaborately worked up by Drs. Kratschmer and Stancovansky, in the *Zeits. für Anal. Chem.*, xxi., 253. Mr. Low's explanations are sufficiently clear to remove

all doubts from my mind as to the reliability of Mr. Pearce's method.—I am, &c.,

LEROY W. MCCAY.

Princeton, September 14, 1883.

YELLOW HYDROCHLORIC ACID.

To the Editor of the Chemical News.

SIR,—“Practical Chemist,” in the *CHEMICAL NEWS*, vol. xlviii., p. 94, calls attention to a statement made by Roscoe and Schorlemmer in their “Treatise on Chemistry” to the effect that the yellow colour of raw hydrochloric acid is due to the presence of *organic matter*. Permit me, if you please, to say a word on this subject.

About a year ago, while stopping in Birmingham, I had an opportunity to examine a carboy of raw hydrochloric acid, which had been sent from an alkali work to the laboratory of a friend of mine, chemist for a certain metal manufacture situated on the outskirts of the city. My friend pronounced the deep yellow colour the result of the presence of organic matter. I failed to agree with him, being well satisfied that the colour was due to ferric chloride. To settle the matter we first endeavoured to discharge, or, at least, partially lighten, the depth of tint of a sample by oxidising the organic matter assumed to be present. Neither potassic chlorate nor permanganate succeeded in producing a definite result, spite the application of heat. Ammonia in excess, however, occasioned a heavy precipitate of ferric hydrate, which, after subsiding, left the supernatant liquid of a light *blue* hue. This blue colour was evidently due to the presence of copper. We made a rough estimation of the iron present, and were astonished to find the percentage so high. The exact amount, I regret to state, has escaped my memory. It may be well to call attention to the fact that Lunge (“Sulphuric Acid and Alkali,” vol. ii., 179-81) does not mention organic matter as one of the *ordinary* impurities of crude hydrochloric acid.—I am, &c.,

LEROY W. MCCAY.

Princeton, September 14, 1883.

ALCHEMICAL TRICKS IN AFGHANISTAN.

To the Editor of the Chemical News.

SIR,—The late Lieut.-Col. Sir Alexander Burnes's, on his visit to Cabul in 1837, found the inhabitants of Afghanistan practising alchemical tricks similar to those which had obtained in Europe from the days of Raymund Lully to the middle of the eighteenth century. His account being quite brief I quote it entire:—

“One of the first applications which we received was from the Nawab, who requested us to supply him with some platina wire to aid his studies in alchymy. I took the occasion to inquire into the state of the science, which has always been in such high favour among the Afghans, and was forthwith made acquainted with several ways of *making gold*, by which the adepts trick their credulous employers. One of these is by secretly introducing some gold inside the charcoal, and, after the quicksilver has been evaporated, the more precious metal is left to delight the wiseacre, and to tempt him on to further expenses. Another method is to put the filings of gold in a stick or pipe, and fasten the end with wax; with this rod the materials in the crucible are stirred, and the desired result obtained.” (“Cabool: a Personal Narrative of a Journey to and Residence in that City in the years 1836, 7, and 8,” by the late Lieut.-Col. Sir Alexander Burnes. 8vo., Philadelphia, 1843.)

This shows that the Afghans possessed, in common with the Chinese, Arabians, and many eastern people, much skill in chemical operations, and an ingenuity in deceiving their fellows worthy of a better cause. The whole passage reminds one of Chaucer's Canon Yeomen's

tale, and of the exposure of transmutations presented to the French Academy by Geoffroy.—I am, &c.,

H. CARRINGTON BOLTON.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvi., No. 10, September 3, 1883.

A Process for the Extraction of Alcohol by means of the Juice of the Melon.—M. Levat.—The author has obtained alcohol from melons after a preliminary treatment with dilute sulphuric acid.

Panary Fermentation.—G. Chicandard.—A reply to MM. Marcano, Moussette, and Boutroux.

No. 11, September 10, 1883.

Separations of Gallium.—Lecoq de Boisbaudran.—See p. 164.

Filtration of very Minutely-divided Precipitates.—Lecoq de Boisbaudran.—It is known that certain precipitates, such as sulphur, in emulsion pass through filter-paper. The author often employs a method which in many cases obviates this inconvenience, and which, to his knowledge, has not yet been made public. Filter-paper is boiled with *aqua regia* until the mass is fluidified; it is then poured into a large quantity of water, and the white precipitate formed is washed by decantation. To render the texture of a filter very compact it is filled with this material, previously stirred up in water, so as to form a very thin paste, and allowed to drain. The paper is thus covered with a layer, which obstructs its pores. Or a little of the same pasty matter may be mixed with the liquid to be filtered.

Experiments made by M. Marcel Deprez at Grenoble, on the Transmission of Power by Electricity.—M. Boulanger.—The author gives his results in the form of tables.

The Cholera from a Chemical Point of View.—Ramon de Luna.—The author contends that the cause of cholera is always in the air, and that its action is exclusively exerted by the respiratory organs. The only means of saving persons attacked is causing them to inhale “with prudence” hyponitric vapour mixed with air.

The Absorption of the Ultra-violet Rays by Albumenoid Substances.—J. L. Soret.—All the albumenoid substances studied contain a common principle, to which their characteristic absorption-band is due. Gelatin, which differs from albumen in many other respects, behaves quite otherwise; it is much more transparent, and shows no band.

Memoir on Flours: Causes of their Decomposition.—M. Balland.—Corn contains an insoluble organised ferment which resists a dry heat of 100°. Its action is to fluidify the gluten.

Biedermann's Central-Blatt für Agrikultur-Chemie, Vol. xii., Part 8.

Influence of Superphosphate upon the Quality of the Harvest.—Prof. Farsky.—The author concludes that superphosphates act like a stimulant, enabling a plant to complete its growth in a shorter time. They increase both the absolute and the relative weight of the seed. Soda-salt-petre in no case increases the weight of the seed, and retards the harvest.

The Reduction of Nitrates in Arable Soil.—MM. Déherain and Maquenne.—The loss of nitrates is due to a "butyric acid ferment," which is developed only in soils completely deprived of oxygen. One of the causes why meadow land is richer in nitrogen than arable soils is the retardation of the process of nitrification.

Influence of Steam Ploughing upon the Quantity of the Yield.—Prof. Mærcker.—This paper has no chemical bearings.

Experiments with Farm-yard Manure and Artificial Fertilisers.—L. Guillaume.—In accordance with Dehérain, Corenwinder, and Pagnoul, the author finds that upon a soil which has been for many years in a well-manured condition, the action of phosphates and even of superphosphates is very slight, the increase of the crop being not sufficient to cover the outlay.

Action of Soluble and Insoluble Phosphates on Barley.—Dr. A. Voelcker.—From the *Journal of the Royal Agricultural Society*.

Manurial Experiments in the Province of Posen.—Dr. E. Wildt.—An account of a number of experiments yielding no decisive results.

Cultivation in the Experimental Field at Grignon in 1882.—P. P. Déherain.—A discussion of the effects of manures, and also of the temperature and rainfall of the year as compared with those of 1880.

Earth-nut Cake and Earth-nut Meal.—Prof. Holdefleiss.—These articles, having had an unfavourable action when used for cattle food, were submitted to microscopic examination, and found to contain the spores of microphytes in great numbers.

American Milk.—Dr. E. H. Jenkins.—The author points out the fluctuations in the total solids of the milk of single cows.

Studies on the Ripening of Grapes.—Dr. C. Amthor.—During the process of ripening a portion of the potassa which previously existed in the state of phosphate combines with tartaric acid.

On Cheese from Skimmed Milk with Foreign Fats.—X. A. Willard, A. B. Griffiths, and J. van den Bergh.

Adulteration of Butter and its Detection.—Dr. E. Schmidt.—The author has obtained good results with Hehner's method only. He rejects especially the process of Husson, and also the methods founded on the determination of specific gravity, and on observation under the microscope (pure butter gives crystals). In examining samples a specimen of pure butter from the same locality ought always to be compared.

Zeitschrift für Analytische Chemie.
Vol. xxii., Part 3, 1883.

Detection of Iodoform, Naphthol, and Chloroform in Animal Fluids.—S. Lustgarten.—A very small quantity of sodium-phenol (or of resorcine) is placed at the bottom of a very short test-tube. One to three drops of the alcoholic solution is then added, and the tube is warmed cautiously over a small flame. In a few seconds there appears a red coating at the bottom of the tube and dissolves in a few drops of dilute alcohol with a carmine colour. In applying this test to urine, Lustgarten distills about 50 c.c.; mixes the neutral distillate with potassa, and shakes it up with ether in a separating-funnel. The ethereal extract is dried at a common temperature, and the residue taken up with a few drops of absolute alcohol. Blood is treated in a similar manner, but alkali should be added before distillation, and the ethereal extract should be mixed with a few drops of sulphuric acid in order to fix bases. For the detection of naphthol the author utilises its behaviour with chloroform in presence of alkali. If α - or β -naphthol is dissolved in strong potassa, mixed with chloroform, and heated to 50°, a rich blue liquid is obtained, which on exposure to the air passes

first to a green and then to a brown. With acids the blue solution turns to a red. For the detection of naphthol in urine, Lustgarten acidifies strongly with hydrochloric acid, distills off about one-half, and extracts the naphthol from the distillate with ether. The residue on the evaporation of the ether is dissolved in potassa, and serves for the application of the test. The distillate may be advantageously treated with animal charcoal at a gentle heat. The same reaction serves inversely for the detection of chloroform.

Crystalline Methæmoglobine.—G. Hüfner and J. Otto.—The authors have succeeded in obtaining this compound in crystals and determining its solubility and colouring-power.

The Behaviour of "Carbon-monoxide Blood" with Hydrogen Sulphide.—E. Salkowski.—Normal blood if diluted with water and shaken up with sulphuretted hydrogen, assumes in a few minutes a dirty green colour. Blood which has absorbed carbon monoxide has its red colour not affected.

Detection of Paralbumen.—E. Salkowski.—The author recommends to add to the diluted liquid in question a few drops of an alcoholic solution of rosolic acid, heat to a boil, and add from a burette decinormal sulphuric acid, stirring occasionally, till the red colour disappears. Serous fluids if thus treated give a clear filtrate. A turbid filtrate indicates paralbumen.

Destruction of Animal Matter.—Paul Jeserich.—Preparatory to the examination for mineral poisons the author destroys the organic matter with free chloric and hydrochloric acids. The mass, comminuted as far as possible, is made up to a thin paste with water, and, after the addition of a little chloric acid, is slowly and cautiously heated on the water-bath, adding gradually more chloric acid in small portions. When the mass swells up like a sponge small quantities of hydrochloric acid are gradually added, but so that the chloric acid may remain in excess. The loss by evaporation must be compensated by the addition of water to prevent the reaction from becoming too violent. The operation is complete in two to three hours.

Detection of Arsenic in Tissues, Paper-hangings &c.—H. Fleck.—The author digests for eighteen to twenty-four hours at 50° to 60° with 50 to 100 grms. of pure sulphuric acid at 25 per cent. If any colours remain upon the objects, an addition of 3 to 5 grms. of pure nitric acid is recommended. The whole is filtered, the residue washed, and the liquids evaporated in a porcelain capsule (if nitric acid has been employed, otherwise not), and the volume is made up to 200 c.c. The detection of arsenic in the liquid is effected by the Marsh process.

Forms for a General Arsenic Regulation.—G. Thoms.—The author proposes to classify articles examined, according to the nature of the mirror produced in ten minutes, as "strongly arseniferous, arseniferous, slightly arseniferous, or free from arsenic," the two former classes being pronounced dangerous to public health. Dragendorff and Reichardt point out certain difficulties, and especially object that a mere knowledge of the presence of arsenic in articles of commerce is insufficient without we know also the state in which it occurs.

Apparatus for the Detection and Quantitative Determination of Arsenic.—J. A. Kaiser.—The apparatus is not described.

Journal de Pharmacie et de Chemie.
Tome viii., September, 1883.

Historical Part of the Discovery of Artificial Soda.—M. Dumas.—Already noticed.

The Toxic Action and the Therapeutical Use of Potassium Dichromate.—M. Vulpian.—A few cases of fatal poisoning with this salt are given. The rapidity with which death comes on is remarkable. It is asserted,

in a passage taken from the *Lancet*, that there are only six manufacturies of the chromates in the world, "three in Glasgow, and the three others in Austria and in the United States." [The writer has omitted the works of Norris Bros. at Sowerby Bridge, near Halifax, where the chromates are manufactured on a large scale.]

Re-solution of Urinary Pigments in Order to Facilitate the Microscopic Examination of Urinary Sediments.—C. Méhu.—The author makes use of a solution of the ordinary sodium phosphate. This solution, saturated in the cold, dissolves, very readily, urobiline, uroerythrine, and the ordinary bile pigments, such as bilirubine and biliverdine.

Action of Fuming Nitric Acid upon Mono-chloric Camphor : Formation of Chloro-nitric Camphor.—M. Cazeneuve.—Already noticed.

MISCELLANEOUS.

Resignation.—Mr. F. J. Lloyd, F.C.S., has resigned his post of Assistant Chemist at the Royal Agricultural Society, which he has held for nearly five years.

British Association for the Advancement of Science.—The following is a complete list of the Committee of Section B (Chemical Science) of the Southport Meeting of the British Association:—A. H. Allen; Prof. J. Attfield, F.R.S.; P. Braham; W. Lant Carpenter, B.A., B.Sc.; Prof. Clowes, D.Sc.; J. T. Dunn, M.Sc.; T. Fairley; A. E. Fletcher; S. Leigh Gregson; F. Hodges; C. T. Heycock, B.A.; Prof. W. N. Hartley; B. P. Lascelles, B.A.; Prof. McLeod, F.R.S.; R. Meldola; R. J. Moss; E. K. Muspratt; Dr. F. Mylius; Stevenson Macadam, Ph.D.; Dr. R. T. Plimpton; Dr. Perkin, jun.; Rev. S. J. Perry, F.R.S.; Prof. W. Ramsay, Ph.D.; Prof. Chandler Roberts, F.R.S.; A. Scott, M.A., D.Sc.; A. Smithells, B.Sc.; G. Johnstone Stoney, M.A., F.R.S.; E. C. C. Stanford; Thomas Tyrer; William Thomson; R. Warrington; M. Whitley Williams; Dr. Will; W. Marshall Watts, D.Sc.; G. Ward; Prof. W. Carleton Williams; C. R. A. Wright, D.Sc., F.R.S.; John Williams; J. A. Wanklyn; Sydney Young, D.Sc.

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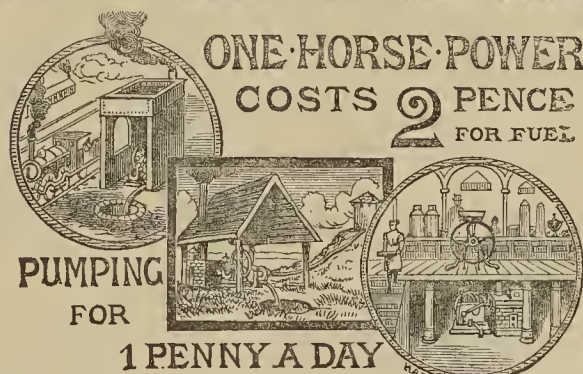
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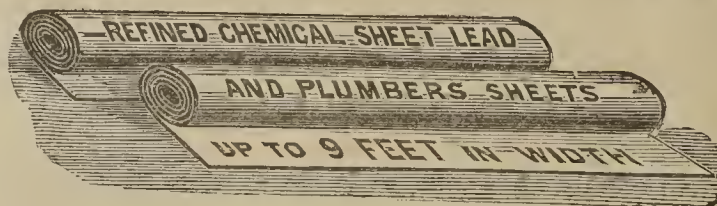
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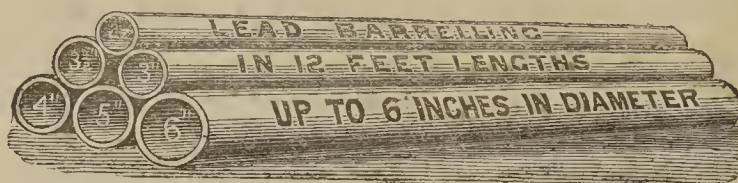
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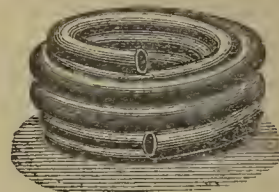
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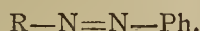
THE CHEMICAL NEWS.

VOL. XLVIII. No. 1246.

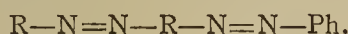
COLOURING MATTERS OF THE DIAZO-GROUP.*

By RAPHAEL MELDOLA, F.C.S., F.I.C., &c.

THE author gave a short historical sketch of this important class of bodies, the discovery of which is due in the first place to Dr. P. Griess. Since the period of their discovery the colouring matters have been very largely investigated by many chemists, owing to their great technical importance, some of the scarlets belonging to the series having practically destroyed the cochineal industry. A large utilisation of many of the waste products of coal-tar, such as naphthalene and the higher homologues of benzene, has at the same time taken place. The compounds hitherto most closely investigated are those formed on the general type—



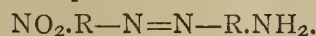
The commercial products known as "Biebrich" and "Croceine" scarlets are secondary azo-bodies of the type—



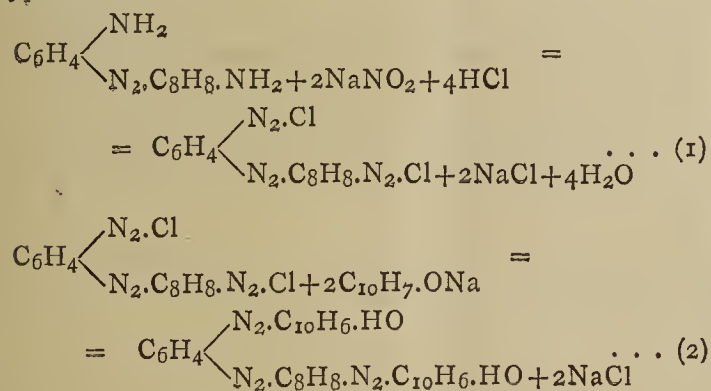
The author has discovered a method of preparing tertiary compounds of the type—



The method consists in first preparing a nitro-derivative of an amido-azo compound:—



The nitro-group can be reduced without severing the nitrogen atoms, and the products, consisting of a series of bases isomeric with those of the chrysoidine series, can be diazotised in both NH_2 groups and combined with two molecules of a phenol. The following reactions are typical:—



ON THE CONVERSION OF OLEIC ACID INTO PALMITIC ACID.*

By W. LANT CARPENTER.

MR. W. LANT CARPENTER read a short paper upon the Conversion of Oleic Acid into Palmitic Acid, and upon fusions with caustic alkalis upon a large scale. Referring to his paper on M. Radisson's process for the industrial conversion of oleic acid into palmitic acid, as printed in the *Journal of the Society of Chemical Industry*, he wished

* Abstract of a Paper read before the British Association, Section B, Southport Meeting.

to supplement that with further details of the apparatus employed.

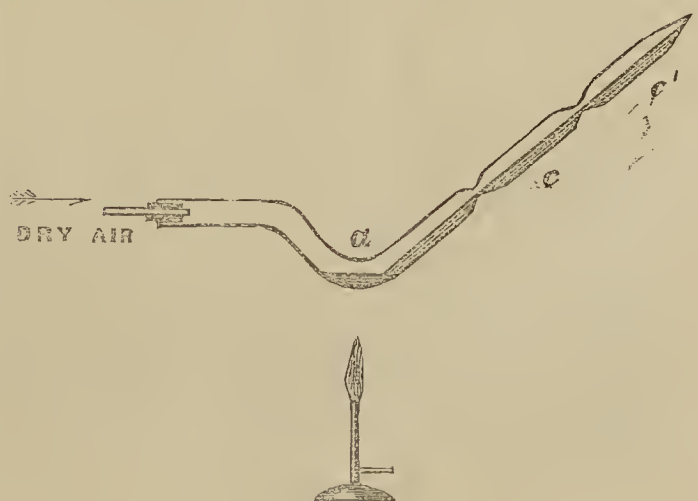
Particulars and dimensions were given of the vessel in which the reaction was effected, and the small limits of temperature within which the change took place were strongly insisted on. Provided attention were given to this, there was no difficulty in conducting these fusions with caustic alkalis, upon this very large scale, in iron vessels.

In connection with this solidification of oleic acid, the author pointed out the fact that the fat of all young animals was richer in oleic acid than that of adults; and also that in the case of adult animals, the better they were fed and cared for the richer was their fat in oleine, in addition to its total quantity being greater: on the other hand, the fat of a poorly-fed adult animal was comparatively poor in oleine, and rich in stearine and the harder constituents. Further, fragments of animal flesh, left in contact with oleic acid and water, effected a more or less complete transformation of oleic acid into harder fatty acids, the whole mass undergoing butyric fermentation at the same time. To what was this transformation of the oleic acid due? Was it possible that some special "microbe" or organism was concerned in the change? The author hoped to have the opportunity of making further researches into this point.

ACTION OF SUNLIGHT ON PHOSPHOROUS ANHYDRIDE.*

By the Rev. A. IRVING, B.Sc.

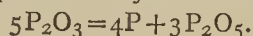
THE only notice I have met with of this interesting example of the effect of a physical agent in promoting chemical change is found in Wislicenus's edition of Streeker's "Chemistry," a work well known in Germany. P_2O_3 , when prepared in a perfectly anhydrous condition, by passing a very slow stream of well-dried air over molten phosphorus contained in the bend (a) of the wide tube shown in the figure, is carried along with the residual nitrogen, and deposited in the wider portions of the long arm of the tube, c c', like small snow drifts. By sealing off the portions c c' the anhydrous P_2O_3 thus



obtained may be preserved from contact with atmospheric moisture and free oxygen, and if kept in the dark remains unchanged for any length of time. Its affinity, however, for free oxygen and water is shown by its spontaneous ignition when one of the tubes is broken, and the trioxide shaken out into the air. The mere heat of the flame used in sealing off the parts of the tube transforms the portion of the trioxide which is in contact with

* A Paper read before the British Association, Southport Meeting (Section B).

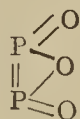
the heated portion of the tube, a thin film of brown phosphorus being formed. The results of prolonged action of direct sunlight are, however, very striking, and as these have not found their way, so far as I am aware, into any of the text-books in vogue in this country, it has occurred to me as possibly worth while to bring the subject before this section, especially since the phenomena seem to suggest one or two points of considerable theoretical interest. A brief notice of the facts was sent in last year, but too late for acceptance by the committee; since then, however, I have had occasion to prepare P_2O_3 several times for lectures, and so have studied the whole thing somewhat more thoroughly. In every case the same results are obtained, if care be taken to dry the air thoroughly, to pass the current very slowly, and to keep the temperature of the phosphorus in the bend of the tube below the temperature which initiates full and complete combustion. The exposure of the sealed-up P_2O_3 to the action of direct sunlight for a few days produces an entire change in the nature and appearance of the contents of the tube: (1) the white colour of the P_2O_3 gives place to the red-brown of amorphous phosphorus; (2) the contents of the tube when thrown into the air are no longer spontaneously inflammable; (3) pure distilled water with which the tube is washed out precipitates a copious yellow powder with ammonium molybdate in the presence of strong HNO_3 even without warming. The amorphous phosphorus which is formed within the tube shows after a time a tendency by slow sublimation to assume the crystalline condition, arranging itself in beautiful moss-like forms of crystal-growth. Prof. Wislicenus suggests for the explanation of the observed transformation a reaction which is represented by the following equation:—



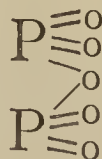
The chief interest of the subject arises from the apparent interference with chemical equilibrium by a purely physical agent; and further interest attaches to the process as furnishing a means for procuring very pure amorphous phosphorus on a small scale.

The explanation of the results observed which I venture to suggest is somewhat as follows:—

Regarding phosphorus as a pentavalent element in combination with oxygen, we may perhaps get to understand the remarkable instability manifested by the P_2O_3 if we represent its composition by the following graphic formula:—



The effect of sunlight* (or of heat) upon the molecule would seem to consist in altering the relative electro-chemical energies of the two elements contained within it. In this way the double bond which holds P to P within the molecule would be severed. While, however, the mutual energy of these centres of saturation for one another is thus weakened or diminished to *nil*, their energy for combining with oxygen is so far increased that they can reduce contiguous molecules of P_2O_3 to amorphous phosphorus. The fully saturated condition of the element in combination with oxygen as P_2O_5 would then, perhaps, be shown in the formula:—



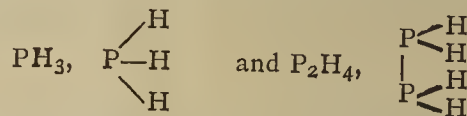
* We may perhaps regard (as Prof. Liveing suggested when this paper was read) the work of partial dissociation as affected by the heat into which the luminous solar radiation is transformed by absorption. If so, it may be further interesting to refer to a little piece of work done by the author last winter in connexion with the physics of glaciers. (See *Nature*, vol. xxvii., April 12, 1883.)

I have not met with any discussion of this interesting point in the various handbooks which have been written on Chemical Philosophy; even in that by Prof. Cooke, of America, it is passed over. In the preparation of P_2O_3 after the method described above, a slight trace of the anhydrous oxide is carried through the tube and escapes with the residual nitrogen into the air. It is too much diluted with nitrogen to become ignited, but passes rapidly into (probably) hydric metaphosphate by combination with atmospheric oxygen and water-vapour. The small stream of visible vapour thus formed does not move on in a continuous line, but folds back upon itself at intervals synchronous with the passage of the bubbles of air through the concentrated sulphuric acid in the desiccating portion of the apparatus. These small folds at once resolve themselves into small "smoke-rings," quite similar to those which are formed by the spontaneous ignition of a mixture of PH_3 and P_2H_4 .

Further, we may extend the reasoning adopted above, to account for the instability of P_2O_3 , to explain the spontaneous ignition of P_2H_4 vapour.

All the best text-books give a method for separating the heavy vapour of P_2H_4 which comes off with PH_3 from a boiling solution of vitreous phosphorus in potash, the method consisting essentially in the condensation of the vapour of P_2H_4 by a freezing-mixture. The fact that PH_3 is not spontaneously inflammable in air is thus demonstrated, though the same fact may be shown by the more simple process of the application of a taper-flame to the bubbles of PH_3 which escape through the water into which the gas is led, before the water gets saturated with the vapour of P_2H_4 , and therefore before the "smoke-rings" begin to appear.

If we represent the constitution of the molecules of PH_3 and P_2H_4 respectively by the following graphic formulæ:—



the more unstable character of the latter body, and its consequent spontaneous ignition in air, would seem to be accounted for. The spontaneous ignition of P_2O_3 and of P_2H_4 are thus referred to one common principle of chemical theory.

Considerable theoretical interest seems to me to attach itself to both the instances considered, as illustrating the facility with which the intra-molecular constitution of some bodies may be disturbed, and the importance of partial dissociation as a preparatory stage to chemical reactions generally; and this must be my excuse for bringing so elementary a subject before the notice of this section.

ON THE EMPLOYMENT OF LIMED COAL IN GAS-MAKING.*

By J. ALFRED WANKLYN.

It has been known for some years past that, in the gas-manufacture as usually carried on, very much less than all the nitrogen contained by the coal is recovered in the form of ammonia. And, in general terms, it may be stated that whereas there is enough nitrogen in the coal employed in gas-making to furnish from 25 lbs. to 50 lbs. of ammonia per ton of coal, the average quantity of ammonia actually recovered is between 5 and 6 lbs. per ton of coal.

Within the last two years attempts have been made to diminish this waste of assimilable nitrogen. One of these attempts has been made in Scotland by Mr. Young, who consumes the heated coal in a current of steam. The

* A Paper read before the British Association, Section B, Southport Meeting.

other attempt, which is very nearly of the same date and quite independent, is embodied in Cooper's liming process, which forms the subject of this paper.

The idea which led up to Cooper's process was that it might turn out to be possible to augment the yield of ammonia with very little disturbance of the ordinary course of gas-manufacture, if a little lime were mixed with the coal as a preliminary to the introduction of the coal into the retort. In that manner it was imagined that without serious sacrifice, either of the gas or of the coke or of the tar, there might be an augmentation of the yield of ammonia. When the experiments were started in the laboratory, before the application was made for the patent, the various other advantages of the employment of a small proportion of lime began to come into view.

One of the earliest observations made by the patentee was that the gas issuing from limed coal, unlike the common gas, was fragrant rather than foetid. Hence, at that early stage, the conclusion was drawn that liming the coal would conduce to the manufacture of pure gas.

In addressing the Chemical Section of the British Association I feel that there can be no necessity for me to explain why the addition of lime to coal should conduce to the formation of ammonia during the process of destructive distillation at a red-heat. In this connection it will suffice for me to anticipate the objection that $2\frac{1}{2}$ per cent of lime (*i.e.*, the proportion which Cooper recommends) is too small a proportion, by the remark that some 70 per cent of the coal is, so to speak, immobile and goes to form the coke, whilst 30 per cent is mobile. On the mobile portion of the coal Cooper's $2\frac{1}{2}$ per cent of lime is not a very small percentage.

As the investigation of Cooper's process progressed, the fact came to light that there is an increase in the yield of tar or in the yield of illuminating gas. At first sight the reason of this may possibly not occur to my hearers. But a little reflection will disclose it. Coal contains carbon, hydrogen, and oxygen, and also some nitrogen, sulphur, and certain fixed mineral matters. After the coal has been most thoroughly dried it will, nevertheless, yield water when it is distilled. In the ordinary distillation of coal very nearly all the oxygen of the coal unites with hydrogen and forms water. Now, suppose that by any means some of that oxygen could be caused not to unite with hydrogen to form water, then hydrogen would be saved for useful purposes, and would go either to augment the yield of gas or the yield of tar. The function of the lime at a red-heat is to hinder the formation of water, and in that manner the lime increases the yield of tar or of gas, as the case may be.

How liming the coal should tend to the production of a gas less charged than usual with sulphuretted hydrogen or sulphuret of carbon will be quite obvious, and needs no explanation.

As has been already said, in the first instance, the hope was indulged that the coke resulting from the carbonisation of the limed coal might prove to be only slightly injured. When the coke was actually produced it was found to be not only uninjured, but in some most important respects it was improved. The presence of the small quantity of lime renders the coke more easily combustible, and the lime acts either as a chemical or a mechanical oxygen carrier. Furthermore, the presence of the lime in the coke prevents the evolution of sulphurous acid when the coke is burned. It would be impossible to insist too strongly on this alteration in the character of the coke, and the introduction of Cooper's desulphurised coke for general consumption in towns will be an event of national importance.

I will now proceed to give an account of the trial workings of Cooper's process at different gas-works.

Gain in Ammonia.—A series of experiments was carried out under the direction of Mr. Tréwby, C.E., the engineer in charge of the Beckton Gas-Works.

These experiments were made on a small scale, and gave as a mean result that there was a gain of 36 per cent

of ammonia consequent on liming the coal. Another experiment at the Commercial Gas-Works, made under the direction of Mr. Jones, C.E., gave the gain of ammonia as 27 or 28 per cent. A third experiment, by Mr. Paterson, of the Cheltenham Gas-Works, was published by that gentleman in his presidential address to the Gas Institute at Sheffield. Mr. Paterson found a gain of 20 per cent of ammonia.

The foregoing results are important from the variety of conditions under which they were obtained, and from the eminence of the engineers who were concerned in them.

I will next mention some trial workings on a much larger scale. Fifty tons of coal were carbonised in the usual manner, and 30 gallons of 7.6 oz. liquor were obtained from each ton of coal.

Fifty tons of the same lot of coal were limed with 3 per cent of quicklime, which was slaked before mixing. The mixture was very imperfectly made. Thirty-five gallons of 8.7 oz. liquor were obtained from each ton of coal. The following is a comparison of the results:—

Unlimed coal	30 by 7.6=228.0
Limed coal	35 by 8.7=304.5

showing a gain by Cooper's process of 35 per cent of liquor.

In a further trial at another gas-works a different description of coal was taken. The coal gave in the usual way only 21 gallons of 8 oz. liquor; but when limed with $2\frac{1}{2}$ per cent of quicklime, slaked before admixture, it gave 42 gallons of 8.1 oz. liquor.

At a gas-works in the South of England, where no cannell is used, Cooper's process has been worked continuously for six weeks, about 50 tons of coal being carbonised daily. The admitted gain is 3 gallons of 8 oz. liquor.

At a gas-works in Liverpool, where much cannell is employed, the process has been worked continuously for between three and four months, on a daily carbonisation of 50 tons of coal, and a gain of 5 gallons of 8 oz. liquor is admitted.

In the course of the last few years I have had abundant opportunities of becoming familiar with the manner in which gas companies deal with the ammonia in gas. The removal of the ammonia from the gas is, as a rule, most successfully managed, fully 95 per cent of the ammonia existing in crude gas being extracted before the gas is delivered for general consumption. But the arrangements for the preservation and storage of the gas liquor are of the most defective character. In the pages of the *Journal of Gas Lighting* the subject of this loss of ammonia has been discussed; and I have been aware almost from the first that one of the hardest tasks laid on those who have charge of Cooper's process will be the task of arousing gas managers to an adequate sense of the necessity of bestowing sufficient care on the gas liquor.

Gain in Tar.—This gain has been observed to arise where there is no diminution either in the volume of the gas or in its illuminating power. In his presidential address to the Gas Institute Mr. Paterson mentioned that he had observed a gain of 13 per cent of tar when Cooper's process was worked. In a trial experiment on 50 tons of limed coal a gain of 6 per cent of tar has been recorded. And, lastly, a gain of 2 gallons of tar per ton of coal was noticed in a working extending over a period of six weeks, at the rate of 50 tons a day.

Diminution in the Sulphuretted Hydrogen and Sulphuret of Carbon.—I will cite an experiment which, through the kindness of Mr. P. J. Wates, I was enabled to make at the Vauxhall Works. A mixture of lime with small coal was made by taking 56 lbs. of quicklime, slaking with 5 gallons of water, and adding 1 ton of coal. Some 12 tons of limed coal was operated upon; and the gas, after passing through the condenser and the scrubber, was tested for sulphuretted hydrogen. In 1000 volumes of the gas Experiment I. gave 3.44 volumes of H_2S , Experiment II. gave 2.45 volumes of H_2S . These measurements of

sulphuretted hydrogen were made by a method described in the *Philosophical Magazine* in the year 1881; and the sulphuretted hydrogen was converted into sulphate of lead and weighed. Crude coal-gas from unlimed coals, according to my experiments, contains from 8 to 15 volumes of sulphuretted hydrogen in 1000 volumes of gas. If it is to be assumed that the Vauxhall gas from unlimed coal contains the least of these quantities of sulphuretted hydrogen, the conclusion is arrived at that, by the operation of liming the coal, the sulphuretted hydrogen had been diminished to between one-half and one-third. I have, however, to remark that the mixing was most imperfect in the above experiment. With good mixing very much better results would be got, and I should expect the sulphuretted hydrogen to fall down to 1.0 volume per 1000 volumes of gas. The diminution of the sulphuret of carbon appears to correspond with the diminution of the sulphuretted hydrogen. The fact of there being a very considerable diminution of sulphuret of carbon has been established by numerous experiments on the largest scale. Early in the present year I managed to persuade Mr. Wates to make trial of the liming process on the entire make of gas in one of the large retort-houses at the Vauxhall Works in London. The quantity of coal carbonised in the retort-house was about 1000 tons a week. The trial working began on January 8th, and with very slight intermission was continued into the month of May. During the first fortnight a little lime was brought into the retort-house, exhibited to the workmen, and then got into the retort anyhow. After the novelty had worn away attention was bestowed on using the right proportion (viz., $\frac{1}{2}$ cwt. of quicklime to each ton of coal), and on getting some kind of approach to a mixture of the materials. The actual mode of operation was of the rudest and most primitive description. The lime, slaked just as if it were to be used in the lime-purifier, was carried into the retort-house in sacks, and the contents of each sack was spread over the exposed face of the heap of coals which lay opposite to the retorts in the retort-house. When the retorts were charged, the coal, with the lime resting on its surface, was partly scraped down and partly allowed to fall down into the scoop used to charge the retorts with coal. In that manner, with the very slightest extra labour (which was paid for by the patentee), and which cost less than one halfpenny per ton of coals carbonised, a sufficient admixture of lime and coal was brought about to occasion the most striking results on the quality of the gas which was produced. As has been said, in the month of January the liming process began to be applied to the entire make of gas in one large retort-house at the Vauxhall Works. There were at that date two other retort-houses at work at Vauxhall, and these two other retort-houses were producing ordinary gas. The possibility therefore arose of instituting a comparison between Cooper's limed gas and common gas from the same quality of coal. So decisive was the superiority of the limed gas, as shown by comparative testings, that Cooper's process was soon applied to a second retort-house, and ultimately it was applied to the third retort-house; and for many weeks about 3000 tons of coal were limed before carbonisation at the Vauxhall Gas Works. In order to illustrate the action of the lime in Cooper's process the following experiments may be cited:—From the hydraulic main of one of the retort-houses in which Cooper's process was being carried on, there was a pipe which conveyed away a small fraction of the gas. This gas was cooled in a separate condenser, washed by its own scrubber, and then passed through three purifiers charged with oxide of iron, and collected in a small gas-holder. On eight different days the gas-holder was in that manner filled with gas, which was afterwards submitted to analysis by the well-known method recommended by the referees. The lowest figure for sulphur present as sulphuret of carbon was 8.7 grains per 100 cubic feet of gas, and the highest figure was 13.73. The quantity of sulphur as sulphuret of carbon in the crude gas at Vaux-

hall, when no lime is put into the retort, is from 30 to 40 grains per 100 cubic feet of gas. When a trifling allowance has been made for the action of the oxide of iron (about 3 grains is a fair allowance), the fall from 35 grains down to about 12 grains expresses the action of the liming process as carried out at Vauxhall.

It had therefore been demonstrated that when Cooper's process was employed the lime-purifier was a superfluity, and for a considerable period the lime-purifier was thrown out of use at Vauxhall. Those persons who are familiar with the details of the gas manufacture will be aware that in order to get the lime-purifiers to remove the sulphuret of carbon from gas many years of labour and experiment were requisite, and that even now gas managers sometimes complain that they cannot get the lime-purifiers to act. The work done at Vauxhall has shown the intrinsic superiority of the Cooper process over the lime-purifier, and I have no doubt that, with the bestowal of a little time and trouble over the details of the mixing, a far higher degree of freedom from sulphuret of carbon would be attained than can possibly be reached by the lime-purifier.

The abolition of the lime-purifier and the substitution of liming process for the use of the purifier will mark an epoch in the history of the gas industry. Hitherto a gas-works has been recognised as one of the most offensive kinds of factory in existence. When a large lime-purifier is opened the foul smell may be perceived at a distance of a mile or two when the wind is favourable, whilst in the immediate proximity of the works there arise bad smells from the gas-liquor, which is most carelessly stored. From the chimneys of the retort-houses sulphurous acid is poured into the atmosphere, to the great detriment of vegetation. By the introduction of Cooper's process all these evils will be remedied, and the gas-factory will cease to be a public nuisance.

THE VOLUMETRIC DETERMINATION OF MANGANESE.

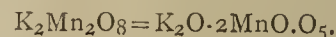
By J. B. MACKINTOSH, E.M., New York.

In a recent paper read before the Institute on this subject, Mr. G. C. Stone advances the theory that the precipitate obtained in Williams's volumetric process,* by treating the boiling nitric acid solution of a manganese salt with potassic chlorate, is not pure MnO_2 , but approximates more closely to the composition $10\text{MnO}_2 + \text{MnO}$.

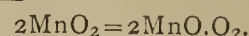
As the value of the process and the accuracy of our results would depend on whether this was the fact or not, it has seemed to me, and to my associates, Messrs. Beebe and Colby, that it would be of importance to ascertain the composition of this precipitate, and to that end the following series of experiments has been undertaken.

These experiments have all been based on the considerations:—

1. That potassic permanganate has an oxidising power equivalent to five atoms of oxygen for every two of manganese:—



2. That the same amount of manganese in the state of binoxide has an oxidising power equivalent to two atoms of oxygen:—



If, then, we take a solution of permanganate of unknown strength, and reduce it to binoxide, the oxidising power of the binoxide formed will be equal to that of two-fifths the quantity of the permanganate solution originally taken. While, if the precipitate obtained should not be binoxide, but an indefinite or definite mixture of bin- and mon-oxides, then, from its equivalent oxidising power, we can calculate its composition.

* Transactions of the American Institute of Mining Engineers, vol. x., p. 100.

The analyses were conducted in the following manner. The amount of permanganate taken was decomposed with hydrochloric acid, and concentrated to expel the excess of water. Sufficient excess of nitric acid was now added, and the solution was boiled until all the hydrochloric acid was destroyed. The manganese was then precipitated by potassic chlorate; and, after standing some time to cool—a precaution which we consider of importance—the precipitate was filtered out through asbestos, washed with nitric acid and then with water, and when perfectly clean was treated with a volume of oxalic acid, whose equivalent in permanganate was known, a few cubic centimetres of sulphuric acid being also added. The excess of oxalic acid was then estimated by permanganate, and the difference between this amount and the equivalent of the whole amount of oxalic taken gave the oxidising power of the precipitate.

To save multiplication of figures we will only give the results obtained:—

$K_2Mn_2O_8$ used.	Oxidising power of precipitate in terms of $K_2Mn_2O_8$.	Theoretical for MnO_2 .	Apparent per cent of theoretical.	Corrected per cent. for burette error.
C.c.	C.c.	C.c.		
45	17'80	18	98'89	99'37
35	13'93	14	99'50	100'07
25	9'90	10	99'00	99'86
15	5'96	6	99'33	100'67

Average true per cent, 99'99

The precipitation in the above results was effected by successive alternate additions of potassic chlorate and nitric acid, until no further formation of yellow fumes were observed. Shortly after first employing the method, we noticed that the reaction was seldom complete when potassic chlorate was added during one period only, and that if, after the apparent completion of the reaction, as marked by the explosive cessation of yellow fumes, more nitric acid was added, and then a fresh portion of potassic chlorate, that the yellow fumes would reappear, again to disappear with the characteristic puff. On this account it is necessary in employing this method to add alternate amounts of nitric acid and potassic chlorate, until no further effect is produced; and, if this precaution is not observed, the results will almost invariably be low.

The next series of experiments was made to illustrate this point, and to determine the amount of error which would be incurred by exactly following the directions given by Messrs. Ford* and Williams in their respective papers, namely, by adding potassic chlorate during one period only, and boiling till the apparent cessation of the reaction. The results obtained were as follows:—

$K_2Mn_2O_8$ used.	Oxidising power of precipitate in terms of $K_2Mn_2O_8$.	Theoretical for MnO_2 .	Apparent per cent of theoretical.	Corrected per cent for burette error.
C.c.	C.c.	C.c.		
40	15'55	16	97'20	97'82
45	17'70	18	98'33	98'92
60	23'37	24	97'40	98'04

Showing an error of from one to two per cent.

The following determinations were made about last February, but no particular record of the details of the manipulation were preserved:—

25	9'93	10	99'30	98'34
50	19'73	20	98'65	99'07

It is evident from inspection of these results, that the first set approach very nearly to the theoretical figure for MnO_2 , the average of the four happening to be 99'99 per cent. This close agreement with the theory must, however, be considered as largely accidental, as the variation in the separate determinations is quite large. In a process of this kind we must consider that the experimental errors are relatively large; indeed, larger than in

the actual application of the method to analysis. These experimental errors, doubtless, balance each other to a large extent by averaging several results, as in the present instance; but we can hardly expect to get such close average results every time.

The burette was calibrated for each analysis by weighing the amount of water delivered corresponding to the various volumes used, and making proportional corrections.

Now, if the composition of the precipitate had been $10MnO_2 + MnO$, as claimed by Mr. Stone, the oxidising power found should have averaged 90'91 per cent. of the theoretical figure for MnO_2 , instead of that which we have actually found; so that the difference is far too great to admit of any doubt as to the true composition of the precipitate. We may safely conclude, then, that the precipitate obtained in this process, when due regard is paid to the precautions which we have indicated, is MnO_2 , and not an indefinite or definite mixture of oxides, that the process is reasonably accurate, and that any estimation based upon the theory that the precipitate is not MnO_2 is of no value, because it is founded on false premises, and therefore can never be true save by accident.

A RECALCULATION

OF

THE ATOMIC WEIGHTS.*

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LEAD.

For the atomic weight of lead we have to consider experiments made upon the oxide, chloride, nitrate, and sulphate. The researches of Berzelius upon the carbonate and various organic salts need not now be considered, nor is it worth while to take into account any work of his done before the year 1818. The results obtained by Döbereiner† and by Longchamp‡ are also without special present value.

For the exact composition of lead oxide we have to depend upon the researches of Berzelius. His experiments were made at different times through quite a number of years; but were finally summed up in the last edition of his famous "Lehrbuch."|| In general terms his method of experiment was very simple. Perfectly pure lead oxide was heated in a current of hydrogen, and the reduced metal weighed. From his weighings I have calculated the percentages of lead thus found and given them in a third column:—

Earlier Results.

8'045 grms. PbO gave 7'4675 Pb.	92'8217 per cent.
14'183 " 13'165 "	92'8224 "
10'8645 " 10'084 "	92'8160 "
13'1465 " 12'2045 "	92'8346 "
21'9425 " 20'3695 "	92'8313 "
11'159 " 10'359 "	92'8309 "

Latest.

6'6155 " 6'141 "	92'8275 "
14'487 " 13'448 "	92'8280 "
14'626 " 13'5775 "	92'8313 "

Mean 92'8271 ± 0'0013

For the synthesis of lead sulphate we have data by Berzelius, Turner, and Stas. Berzelius,§ whose experiments were intended rather to fix the atomic weight of sulphur, dissolved in each estimation 10 grms. of pure lead in nitric

* Smithsonian Miscellaneous Collections. "The Constants of Nature."

† Schweig. Journ., 17, 241. 1816.

‡ Ann. Chim. Phys., 34, 105. 1827.

|| Bd., 3, s. 1218.

§ Lehrbuch, 5th ed., 3, 1187.

* Ibid., vol. ix., p. 397.

acid, then treated the resulting nitrate with sulphuric acid, brought the sulphate thus formed to dryness, and weighed. 100 parts of metal yield of PbSO_4 .

146.380
146.400
146.440
146.458

Mean 146.419 \pm 0.012

Turner,* in three similar experiments, found as follows:—

146.430
146.398
146.375

Mean 146.401 \pm 0.011

In these results of Turner's *absolute* weights are implied.

The results of Stas' syntheses,† effected after the same general method, but with variations in details, are as follows. Corrections for weighing in air are applied:—

146.443
146.427
146.419
146.432
146.421
146.423

Mean 146.4275 \pm 0.0024

Combining, we get the subjoined result:—

Berzelius	146.419 \pm 0.012
Turner	146.401 0.011
Stas	146.4275 0.0024

General mean .. 146.4262 \pm 0.0023

Turner, in the same paper, also gives a series of syntheses of lead sulphate, in which he starts from the oxide instead of from the metal. 100 parts of PbO , upon conversion into PbSO_4 , gained weight as follows:—

35.84
35.71
35.84
35.75
35.79
35.78
35.92

Mean 35.804 \pm 0.018

These figures are not wholly reliable. Numbers one, two, and three represent lead oxide contaminated with traces of nitrate. The oxide of four, five, and six contained traces of minium. Number seven was free from these sources of error, and, therefore, deserves more consideration. The series as a whole undoubtedly gives too low a figure; and this error would tend to slightly raise the atomic weight of lead.

Still a third series by Turner establishes the ratio between the nitrate and the sulphate; a known weight of the former being in each experiment converted into the latter. 100 parts of sulphate represent of nitrate:—

109.312
109.310
109.300

Mean 109.307 \pm 0.002

In all these experiments by Turner the necessary corrections were made for weighing in air.

For the ratio between lead chloride and silver we have a series of results by Marignac and one experiment by Dumas. There are also available data by Turner and by Berzelius.

Marignac,* applying the method used in his researches upon barium and strontium, and working with lead chloride which had been dried at 200°, obtained these results.

The third column gives the ratio between PbCl_2 , and 100 parts of Ag:—

4.9975 grms. PbCl_2	= 3.8810 Ag.	128.768
4.9980	" 3.8835 "	128.698
5.0000	" 3.8835 "	128.750
5.0000	" 3.8860 "	128.667

Mean 128.721 \pm 0.016

Dumas,† in his investigations, found that lead chloride retains traces of water even at 250°, and is sometimes also contaminated with oxychloride. In one estimation 8.700 grms. PbCl_2 saturated 6.750 of Ag. The chloride contained 0.009 of impurity; hence, correcting, Ag: PbCl_2 :: 100 : 128.750. If we assign this figure equal weight with those of Marignac, we get as the mean of all, 128.7266 \pm 0.013. The sources of error indicated by Dumas, if they are really involved in this mean, would tend slightly to raise the atomic weight of lead.

The synthesis of lead nitrate, as carried out by Stas,‡ gives excellent results. Two series of experiments were made, with from 103 to 250 grms. of lead in each determination. The metal was dissolved in nitric acid, the solution evaporated to dryness with extreme care, and the nitrate weighed. All weighings were reduced to the vacuum standard. In series A the lead nitrate was dried in an air current at a temperature of about 155°. In series B the drying was effected *in vacuo*. 100 of lead yield of nitrate:—

A.

159.973
159.975
159.982
159.975
159.968
159.973

Mean 159.9743 \pm 0.012

B.

159.970
159.964
159.959
159.965

Mean 159.9645 \pm 0.0015

Mean from both series 159.9704 \pm 0.0010

There still remain to be noticed two sets of experiments upon lead nitrate, which were originally intended to establish the atomic weight of nitrogen. Lead nitrate was carefully ignited and the residual oxide weighed. The first series, bearing Svanberg's name,§ gives simply the percentage of oxide found, as follows:—

67.4030
67.4036
67.4043
67.3956

Mean 67.4016 \pm 0.0014

The second series is by Anderson,§ and gives the weighings upon which the percentages rest. The latter come out thus:—

5.19485	PbN_2O_6 gave	3.5017 PbO ,	67.4071 per cent
9.7244	"	6.5546 "	67.4037 "
9.2181	"	6.2134 "	67.4044 "
9.6530	"	6.5057 "	67.3957 "

Mean 67.4027 \pm 0.0016

* *Journ. f. Prakt. Chem.*, 74, 218. 1858.

† *Ann. Chem. Pharm.*, 113, 35. 1860.

‡ "Aronstein's Translation," 326.

§ *Journ. f. Prakt. Chem.*, 27, 381. 1842.

§ *Ann. Chim. Phys.*, (3), 9, 254. 1843.

* *Phil. Trans.*, 1833, 527-538.

† Aronstein's Translation," 333.

It will at once be seen that these series are identical; the discordance between the first figures of the two being undoubtedly due to some misprint in the weighings of the Anderson set. How it happens that the same work has been published by two separate authors I will not attempt to explain; neither will I undertake to determine which of the two is really entitled to credit.

We have now seven ratios upon which to base our computations:—

(1.) Per cent. of Pb in PbO, 92.8271	± 0.0013
(2.) Per cent of PbO in PbN ₂ O ₆ , 67.4016	0.0014
(3.) Pb : PbSO ₄ :: 100 : 146.4262	0.0023
(4.) PbO : PbSO ₄ :: 100 : 135.804	0.018
(5.) PbSO ₄ : PbN ₂ O ₆ :: 100 : 109.307	0.002
(6.) Pb : PbN ₂ O ₆ :: 100 : 159.9704	0.0010
(7.) Ag : PCl ₂ :: 100 : 128.7266	0.013

Discussing these separately, we get an equal number of value for the atomic weight of lead:—

From (1)	Pb = 206.587 ± 0.059
" (2)	" 207.046 0.041
" (3)	" 206.435 0.041
" (4)	" 207.131 0.118
" (5)	" 204.803 0.329
" (6)	" 206.454 0.037
" (7)	" 206.473 0.042

General mean 206.604 ± 0.019

If O = 16, this becomes Pb = 207.079.

In the above discussion are included several values which diverge widely from this general mean, and which, for other reasons, are probably erroneous. Although but one of these carries much weight, it is as well to exclude them, and to base our computations upon the others. If, now, we reject the second, fourth, and fifth values, we get for the atomic weight of lead, Pb = 206.471 ± 0.021. If O = 16, this becomes Pb = 206.946.

From the synthesis of the nitrate Stas found 206.918, and from the sulphate, 206.934. The agreement of these values with our own general mean is certainly very close.

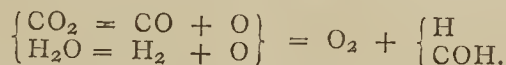
NOTES ON LOEW AND BOKORNY'S RESEARCHES ON THE PROBABLE ALDEHYDIC NATURE OF ALBUMIN.

By A. B. GRIFFITHS, M.A., Ph.D., F.C.S.,

Member of the Liverpool Association of Science and Arts; Medallist in Chemistry and Botany, &c.

THE remark of Emerson "what we know is a point to what we do not know" is very applicable to the present state of our knowledge of albumin. Professor Schorlemmer ("Rise and Development of Organic Chemistry," page 123) says, "the enigma of life can only be solved by the discovery of the synthesis of an albuminous compound." The direct synthesis of albumin from its elements has never been conducted; but we know that it consists of a very complex molecule of 225 atoms (C₇₂H₁₁₂N₁₈SO₂₂). As to how these atoms are grouped together we know nothing. Of late there has been some excellent work done by MM. Loew and Bokorny in this line of research, which opens a vast field of enquiry for the physiological chemist. They have been paving the way for the synthesis of this compound. In their researches on living and dead protoplasm they came to the conclusion that living protoplasm contains an aldehyd group of elements.* From their experiments on the living protoplasm of the fresh-water algae, *Spirogyra* and *Zygnema* growing in spring-water con-

taining 0.1 per cent of dipotassium phosphate and ammonium nitrate, they found that the living cells had the power of reducing silver from a very dilute alkaline solution of the metal. Dead cells do not give this reaction. The authors have experimented upon the cotyledons of the sunflower (*Helianthus annuus*), the epidermal hairs of plants, the sap of the pine and oak, the cells of fruits, fungi, and also many of the infusoria, with the same result. From these observations they conclude that living protoplasm contains an aldehyde group of elements, whereas there is no such group in dead protoplasm. Reinke (*Berichte der Deutschen Chemischen Gesellschaft*, 15, 107, and 14, 2144) says that the aldehydic character as tested by an alkaline silver solution is only a property of the protoplasm of the chlorophyll, for he does not find it in the protoplasm of cells in unopened buds; therefore he thinks it is probable that it is formed only in the presence of sunlight by the chlorophyll corpuscles. Mori (*Chemisches Centralblatt* [3], 13, 565) considers that formic aldehyd is the first product of assimilation, for he detected (by the action of a solution of nitrate of silver) a substance which reduced the nitrate in plants containing chlorophyll which had been exposed to sunlight. When the same plants were left for about 48 hours in a dark place, so that on applying the test again the first products of assimilation might be used up, no reduction of silver took place. Therefore, both Reinke and Mori support Baeyer's theory that formic aldehyde is formed by chlorophyll under the influence of light from the carbonic acid of the atmosphere:—



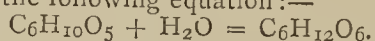
Kretzschmar ("Biedermann's Centralblatt für Agricultur-Chemie," 1882, 830), on the other hand, states that the protoplasm of living and dead *Spirogyra* reduces silver from an alkaline solution of the metal, and so concludes that this reagent fails to distinguish between living and dead protoplasm.

Having been working of late on the cell-contents of plants,* I have gone over a good portion of the experimental work which led Loew and Bokorny to their conclusions; and in this communication (which was the substance of a paper of mine read before the Chemical Society on June 7th last, but contains additional experiments and observations) I am desirous of detailing a few observations I have noticed in the case of *Spirogyra*. I found on treating it with a dilute alkaline solution of a cupric salt, that in the protoplasm of the living cell red cuprous oxide was precipitated, the same reaction being observed in the case of dead protoplasm. On treating the living cells of this plant with a weak solution of sodium chloride under the power of the microscope, it was observed that crystals were formed in the protoplasm. When the live or dead cells of *Spirogyra* are treated with absolute alcohol and allowed to stand for a few hours, needle-shaped crystals of anhydrous dextrose were formed in the cells. From these and further observations to be described presently, I am inclined to think that the body which has the reducing effect on metallic solutions is one of the glucoses, and most likely the crystals observed (when the cells were treated with sodium chloride solution) have the formula C₆H₁₂O₆.NaCl.H₂O for it is well known that dextrose forms a crystalline body of this composition with sodium chloride. To confirm my observations as far as possible, I took the albumin (the white) of a newly laid egg, and mixed with it a small quantity of a very weak solution of dextrose, and then placed some of the mixture on the slide of the microscope. I now ran in the weak NaCl solution (of the same strength as used with the living and dead cells of *Spirogyra*), and after some hours standing I observed crystals exactly like those observed when experimenting with the cells of the plant. I tried also the

* "Die Chemische Kraftquelle im lebenden Protoplasma," von Oscar Loew and Thomas Bokorny, *Berichte der Deutschen Chemischen Gesellschaft*, 14, 2508; and 15, 695. *Fflüger's Archiv. für Physiologie*, 25, 150.

* "Chemico-Microscopical Researches on the Cell-contents of Certain Plants," by A. B. Griffiths, *Journal of the Chemical Society, Transactions*, 1883, page 195.

"copper test" and the "alcohol test" respectively on the mixture of egg-albumin and dilute dextrose, and obtained similar results to those observed in the living and dead cells of *Spirogyra*. The reduction of the copper and also of Kretzschmar's silver solutions in both the living and dead cells goes to confirm the supposition that this form of sugar is in the cells of *Spirogyra*. Further, if the *living plant* be kept in the dark for a couple of days, no reduction of copper or silver solutions takes place, and no crystals are formed when sodium chloride solution is given to the living cells; and no needle-shaped crystals are formed with absolute alcohol. The above results may be due to the whole of the dextrose being used up in the dark, for we know that carbohydrates go to nourish the cell-wall and tissues. On exposing the plant again to sunlight for a short time, and on treating with the same alkaline cupric solution and the solution of sodium chloride, the same phenomena were observed. Schorlemmer ("Chemistry of the Carbon Compounds," page 290), considers the constitution of dextrose to be "the first aldehyd of the hexad alcohol mannite," from the fact that an aqueous solution of dextrose when treated with sodium amalgam is converted into mannite, and that it reduces silver and other metals from their compounds. Levulose, another member of the family of glucoses, is also considered to be an "aldehyd of a hexad alcohol," reducing silver and copper from their solutions, and by oxidation it yields glycollic acid; whereas dextrose yields gluconic acid, and ultimately saccharic acid. Cane sugar is generally looked upon as an ether. It does not reduce salts of silver and copper, and does not form crystals with sodium chloride; in fact it is not an aldehyd; both dextrose and levulose from these considerations are aldehyds. The glucose which I found when examining the living and dead protoplasm of *Spirogyra* was dextrose (right-handed glucose) and not levulose (left-handed glucose), for levulose does not form a crystalline compound with sodium chloride solution. Again, if levulose had been present when treating with the "alcohol test," no needle-shaped crystals would have been precipitated; for absolute alcohol does not precipitate levulose. If, as Mori thinks, aldehyde is the first product of assimilation, then I think it most probable that it is soon converted into starch, or some of its isomers, by the action of chlorophyll in the presence of light, or by leucoplastids in the absence of light. This starch or carbohydrate is ultimately used up, as is well known, in nourishing the growing tissues and cell walls; but before it is so used up I think it most likely that it is converted into dextrose, according to the following equation:—



Whether an aldehydic substance is the basis of living protoplasm or not it is difficult to say, but Loew and Bokorny have certainly a large number of facts in favour of their hypothesis. What is known is that some carbohydrate is the starting point for all organic compounds. To conclude, I think such researches as these will greatly help chemists in the synthesis of albumin, or, as it has been called, "the basis of life"; such a discovery would be the greatest of all triumphs of synthetical chemistry. Someone may say "supposing albumin to be built up from its elements it will be different to that found in *living* animals and plants." I think not, as my learned master and friend, Professor Schorlemmer, Ph.D., F.R.S. ("Rise and Development of Organic Chemistry," page 122) says: "If ever chemists should succeed in obtaining albuminous bodies artificially, it will be in the state of *living protoplasm*, perhaps in the shape of those structureless beings which Hæckel calls the "Monera," or as Huxley puts it in his "Invertebrata": "It must not be supposed that the differences between living and not living matter are such as to bear out the assumption that the forces at work in the one are different from those which are to be met with in the other. The phenomena of life are all dependent upon the working of the same physical and chemical forces as those which are active in the rest of the world."

PROCESS FOR THE MICROSCOPIC EXAMINATION OF WATER FOR ORGANIC IMPURITIES.

By J. BRAUTLECHT.

THE author produces a precipitate in the water by adding to 100 c.c. 5 drops of a solution consisting of one part aluminium sulphate, one part hydrochloric acid, and 8 parts water, followed up by 1 to 3 drops of liquid ammonia. The precipitate settles readily, and after decanting off the clear is collected upon a smooth filter, stroked off with a glass rod, and thus transferred to a test-tube, in which it is dissolved in 10 to 15 drops of dilute acetic acid. The clear solution is examined with the microscope, at first alone, and then after the addition of a solution of saffranine. By adding $\frac{1}{2}$ per cent of gelatin, permanent preparations may be obtained on Koch's principle.—*Rep. Anal. Chemie und Chem. Zeitung* (Coethen).

NOTICES OF BOOKS.

The Practical Laboratory Guide in Chemistry. By DAVID O'BRINE, B.S., M.E., Assistant in Chemistry in the Ohio State University. Columbus, O.: A. H. Smythe, 1883.

IN compiling a book on practical chemistry, or on any other subject, the compiler may be actuated by two motives, either that of his own material benefit, or the benefit of the class of students to whom he addresses himself. To compile a work when the author is animated by the former spirit is a comparatively easy matter now that encyclopædias and dictionaries of science are so numerous, and publishers are not considered responsible for the rubbish they are the means of throwing upon the world already so heavily burdened in this respect. But to arrange facts and describe phenomena in a manner that may help a student in his conceptions of scientific ideas, and lessen his difficulties in his first essays among the mysterious intricacies of the material world, requires all the experience and judgment of a teacher long habituated to associate with pupils of all degrees of mental calibre. In our laboratories in this country we have several excellent treatises on elementary practical chemistry written by teachers who were amply qualified to undertake the task; still, in spite of the almost universal use of these few typical books, whether it arises from the defects in these text-books, or the presumptuousness of junior demonstrators, each year sees its ever increasing quota of new manuals professing to teach the principles of chemistry, but which, in the vast majority of cases, show them, upon the briefest examination, to have been compiled with apparently total ignorance of what an elementary student really does require. It is not a mere statement of facts, or the correctness of formulæ and equations brought together in a *multum in parvo* fashion, that constitute the value of a guide-book; for these statements can be worded in such terms, or the formulæ thrown together in such a higgledy-piggledy manner, that the learner might as profitably attempt to imbibe chemistry from the writings of the old alchemists, or the hieroglyphics of the Egyptians.

Among the quite recent additions to our literature we have here a laboratory guide-book, in which the first thing that attracts our notice is a long list of *errata*, which, by the way, is not nearly complete. The misprints, although not of serious importance, are such as one might expect to see in a daily newspaper, but never in a fashionable novel: as "crucibel," "analases," "pipetts," "selenium," "vanadium," "Priestly."

Glancing at the symbols that adorn the pages we are struck by the great want of uniformity in the method of writing the formulæ of many of the compounds, and a

divergence from what we are accustomed to see in our modern recognised text-books, as well as what may seem to be the introduction of a concise method of stating certain facts about the compounds. This innovation of the authors consists of a stroke written over the formula to indicate that the body is given off as a gas, and underneath it forms a precipitate. As an illustration of this new complication of matters we take the following sentence:—

"When KIO_3 is heated, $\bar{\text{O}}_3$ as $\text{KIO}_3 = \text{KI} + \bar{\text{O}}_3$."

Brackets, too, are used in a way we have never seen before, and without explanation, as—

" $2(\text{K}_2\text{OH}_2\text{O}) + 4\text{Cl} = \text{K}_2\text{OCl}_2\text{O} + 2(\text{KCl}) + (\text{H}_2\text{O})_2$."

Chapter I., on the preparation of reagents, contains the usual instructions for making these solutions; the language in some cases, however, is vague. What does the author mean by this, under the preparation of potassium nitrite? "It will be noticed that if N_2O_3 is passed in (KHO) a nitrite is formed; but if from any reason NO_3 , a nitrate will be formed; the truth is a mixture of nitrate and nitrite is formed." For our part we can "notice" nothing to indicate this strange phenomenon.

Chapter II. gives the definitions of atom, molecule, &c., which, however, are stated in far too few words, and in somewhat foggy language. From these definitions we select a few:—"A radical is the residue of a molecule, and acts like the atom, as a unit (HO) hydroxyl." But why not explain the word residue, taking such a formula as NH_4 ? "A binary compound is the union of two elements." "Acids are electro-negative binaries which are generally formed by the union of oxygen with non-metal." "An acid is a compound of hydrogen with a negative atom or radical; as, (HCl) hydrochloric acid, (H_2OSO_3) sulphuric acid." Now, taking these last three "definitions" together, will anyone tell us what is an acid and what a binary compound? But more extraordinary still is this one: "A reaction is representing chemical changes by their symbols"! We are accustomed to use such phrases as, "bodies react upon each other chemically," or "a chemical reaction is taking place." And what is usually meant by these expressions? In a chemical reaction—using the term in its generally received sense—or state of chemical change, is not the very mystery of mysteries of matter exhibited to our senses, and the full understanding of which the aim and goal of all true chemistry? Truly if a "reaction" be but the expression of chemical changes by "their" symbols, the symbols are as yet infinitely defective, although the author does give an example to illustrate his definition.

Chapter III., on "tests in the dry way," pleases us to see this important subject treated so fully. This seems indeed, to be the best chapter in the book. Thallium, we notice, is absent from the flame reactions, although perhaps it is more frequently met with than lithium. Some of the hints in this chapter might have been omitted; as, "If you have a solution of lead or the alkaline earths you need not look for sulphuric acid." Supposing calcium and ammonia found, on the strength of this hint would not the student omit to search for sulphuric acid?

The final parts of this book are taken up by subjects which are not usually given to a general student after an elementary course in qualitative analyses, as the analyses of water, milk, cheese, urine, and poisons; one chapter, too, is on the examination of ptomaines! If the work had been designed for the medical student only, one could understand this, but the preface tells us that "The object is to present a practical guide in chemistry adapted to the wants of the college or the medical laboratory." Yet many of the physiological facts may be of interest to the analytical chemist, and well worth remembering if he should be ever called upon to report on articles of food or drinking-waters; for example, "Bad water may effect (*sic*) the stomach and cause dyspepsia, cholera, &c."

Chapter III. of Part 6, on the laws of chemical incompatibility, we should have liked to have seen extended to

a greater length, with a few examples by which we, as well as the tyro, might have benefited. Here, under "Berthollet's Law," we have eight statements, without any comment, but to make out which one is the "law" puzzles us very much. We give abstracts of the first and last:—

"1. Two salts in solution may form by the interchange of their acids and bases, two insoluble salts, which are precipitated. . . ."

"8. The following substances are best given alone:—Hydrocyanic acid, nitro-hydrochloric acid, . . . the poisonous metals combined with acetic acid, and, in general, the alkaloids."

The physiological section ends with a chapter on man, who is "nothing but six pails of water combined with twelve to fourteen pounds of solid matter," in which the data of daily waste and supply of an average man usually found in works on physiology are given. This chapter concludes with a sentence which, as appearing in a work on chemical analyses, we cannot refrain from quoting:—"In the language of my friend and teacher, Prof. Norton, 'The apparatus is a living machine governed by an immortal soul, working for itself and others. The machine finally wears out, leaving about seven pounds of lime salts to the hundred, and a memory deathless for a chosen few, weak and fugitive for the great majority. Nevertheless, life is worth living if we have the approval of a good conscience'!"

It may be that Mr. O'Brine, who is a teacher, writes this book for a select class of students whose mental constitution he is better acquainted with than we are, and is probably, therefore, a better judge of what kind of pabulum should be served up for them. Perhaps, also, as the book may prove of service exclusively in his own classroom, his disquisitions on the foggy points may render its study a pastime. Still we hope that, should a second edition be called for, we shall see a little more pains taken to ensure clearness, even at the expense of redundancy.

That the principles and facts of chemistry have been acquired by Mr. O'Brine we have no doubt, but to put these on paper requires more trouble and care than he has evidently given the matter.

Workshop Receipts. By ROBERT HALDANE. Second Series. London: E. and F. N. Spon. 1883.

THIS little book, the author tells us in his preface, forms a second series of his original "Workshop Receipts," published a few years ago. The favourable reception that was given to the first compilation indicated that the author has supplied a want long felt amongst experimenters and manufacturers, and, encouraged by this success, the present volume has been written on the same pattern as the original.

By the title that is given to this book one would be inclined to expect the information to relate principally to mechanism and the mechanical arts, but instead of it being so the subjects here brought together have reference almost exclusively to the chemical trades, and probably therefore this volume may prove to be of comparatively greater utility to the chemical technologist than to the mechanician.

The contents, which are in alphabetical order, range from acidimetry to preserving, and between these two extremes we have a heap of valuable information and receipts relating to numerous subjects intimately connected with the lesser chemical industries. Under bleaching we have recipes for bleaching and decolourising albumen, coral, feathers, sponge, wax, &c. Cements and lutes, the directions for their preparation and application, forms a valuable section of the book, as the number of recipes given would seem to be sufficient in variety to be applicable to everything that is breakable and stickable from alabaster to wood and zeiodolite. Under boiler incrustations a fair synopsis is given of what is known regarding this plague, and a short critical examination of many of

the different processes that have been brought forward from time to time to remedy the evil. Cleansing, copying, dyeing, and staining pigments, essences, and extracts are fully represented by great numbers of formulæ. The mysteries of the confectioners' art, too, are explained at some length, which matter, however, seems to be rather out of place in a book of workshop receipts. Nor are such useful agents as matches, ink, glue, &c., forgotten. In many places the author gives references to the sources from which he has derived his information; this certainly may be valuable to those who wish to consult the original authorities, but merely to name the journal from which the information is derived, without giving either the date or volume, renders such references well nigh useless.

About Photography and Photographers. By H. BADEN PRITCHARD, F.C.S. London: Piper and Carter.

PHOTOGRAPHERS, whether they belong to the professional or to the amateur class, who take up this little book of Mr. Pritchard's with the hope that, coming from such an authority on photographic matters, it may assist them over their difficulties in the production of a really artistic picture, creditable both to themselves and the makers of their apparatus, will in a certain sense be disappointed. In place of a string of rules and formulæ about exposure, lenses, developers, and such like, we have here a series of short and most entertaining essays for the studio and study, to which are added Continental rambles with a camera. The subjects of these essays are of general interest to photographers outside the operative room, and, written in a pleasant style, will afford much amusement combined with instruction to everyone who is in any way connected with the photographic art. In the first essay, "The First Camera Photograph," an account is given of M. Niépce's early struggles in making his discovery, the narrative being rendered highly interesting by short abstracts from his private letters regarding the gradual development of his process and the obstacles he had to contend with.

In the numerous essays that follow, the reader will find material which will afford several agreeable half-hours' reading. "About Medals," "Business Taft," "Photographers by Diploma," and "Publication of Photographs," may interest some of our art aspirants.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Moniteur Scientifique, Quesneville.
September, 1883.

Notice of Foreign Researches in Organic Chemistry.—G. de Bechi.—Translations from the *Berichte der Deutsch. Chem. Gesell.* and the *Journal für Praktische Chemie*.

The Alizarine Industry.—Ivan Levinstein.—An abstract of a paper read before the *Society of Chemical Industry*.

Lecture on the Artificial Reproduction of Organic Matters of Animal or of Vegetable Origin.—Emile Jungfleisch.—A paper read before the *Société d'Encouragement*, and already noticed.

New Applications of Incombustible Paper and Colours.—M. Meyer.—An account of experiments showing the fire-proof character of the author's paper.

The "Gelis" Sulpho-carbometer.—This paper, which is almost an advertisement, cannot be intelligibly reproduced without the accompanying illustration.

Disinfection of Alcohols of Bad Flavour by means of Electrolysis.—Laurent Naudin.—Already noticed. It is necessary to protest against the misuse of the term "disinfection" in the title of this paper.

A Remarkable Case of Chyluria, and the Presence of Caseine in Urine.—Dr. A. Loison and E. Leger.—The urine examined is characterised by the presence of caseine, a compound not yet proved to occur in that excretion. The caseine did not appear to be derived from the blood of the patient. The same urine contained also from 3.25 to 4.11 grms. of fatty matter per litre, whilst in the blood only 2.05 grms. per litre were present. The authors give the provisional name of urocaseine to the form of caseine found, reserving the question of its identity with the caseine of milk.

Industrial Society of Mulhouse.—The Ohemical Committee met July 11. M. Horace Kœchlin read the results of experiments made on the fixation of colours by means of gelatine rendered insoluble by potassium dichromate. Mineral colours and certain aniline colours are thickened with gelatin, and printed upon cloth prepared with sodium hyposulphite, and then passed through potassium dichromate. The colours bear soaping at boiling-heat, and the action of light.

M. Lussy presented a report on the theory of Turkey-red dyeing, and on the constitution of the sulpholeates.

M. Noeltling gave some details on the azo- and diazo-derivatives of the cresylols.

Preparations of Ergot founded upon Recent Researches.—C. S. Hallberg.—From the *Pharmaceutical Journal*.

Uranium Oleate.—W. Gibbons.—A paper read before the Pharmaceutical Society.

Analysis of the Sulpho-carbonates.—O. Hehner and H. S. Carpenter.—From the *Analyst*.

Essence of Angelica.—Laurent Naudin.—Already noticed.

Justus Liebig's Annalen der Chemie,
Band 219, Parts 2 and 3.

Chloride of Lime and certain Analogous Bodies.—G. Lunge and P. Naef.—The authors' results are that Kraut's objections against the formula $\text{Cl}-\text{Ca}-\text{OCl}$, adopted by Lunge and Schäppi, are groundless. The assumption of a decomposition of calcium chloride by the joint action of carbonic and hypochlorous acids is a confusion of two reactions, which are not simultaneous but successive. Hypochlorous anhydride decomposes calcium chloride at common temperatures, liberating chlorine, and forming a mixture of chloride of lime with excess of calcium chloride, and probably a little calcium hypochlorite, but no free lime. Hydrated lithia is converted by chlorine into chloride of lithia to a much greater extent than is stated by Kraut. The chloride is not stable in presence of excess of chlorine, but is resolved into lithium chloride and free oxygen to a much greater extent than chloride of lime under similar conditions. It is, however, much less affected by carbonic acid than is chloride of lime. The behaviour of chloride of lithia differs so much from that of chloride of lime that the molecular structure of the two compounds is probably dissimilar. Products resembling chloride of lime can also be obtained from the bivalent metals, strontium and barium,—with the latter only, however, under conditions not yet ascertained.

Synthesis of Tyrosine.—E. Erlenmeyer and A. Lipp.—If to a solution of the hydrochlorate of amido-phenyl-alanine there is gradually added nitrous acid, either as nitrous anhydride or sodium nitrite, at 0° , no escape of gas takes place, but as soon as the liquid is raised to a boil much nitrogen escapes, and there remains tyrosine, either alone or accompanied with undecomposed amido-phenyl-alanine. The authors regard tyrosine as para-hydroxy-phenyl-alanine.

Derivatives of Cinnamic Acid obtained during Experiments on the Synthesis of Tyrosine.—E. Erlemeyer and A. Lipp.—This very lengthy paper does not admit of useful abstraction.

Researches on Hydroxilation by Direct Oxidation.—R. Meyer.—The first portion of a very extensive memoir, not adapted for abridgment.

Communications from the Laboratory of the University of Würzburg.—These consist of a paper by J. Wislicenus on methyl- β -butyl-ketone and certain of its derivatives; researches on the mono-halogenic substitution-compounds of crotonic acids, by Dr. R. Friedrich; and a continuation of the same subject by the same author.

The Position of Thallium in Chemical Systematics, and its Occurrence in the Sylvine and Carnallite of Kalusz.—Julian Schramm.—The author refers to the known fact that elements approaching each other in their physical and chemical characters occur together in nature, but that their relative quantity decreases in proportion as their atomic weights increase. Hence an element may, in doubtful cases, with great probability be referred to that group with which it is found associated. In order to decide the disputed position of thallium, he enumerates the cases in which it has been found along with alkaline metals. It has thus occurred in lepidolite, mica, in the alums of the Island Vulcano, in the salt springs of Nauheim, and in the carnallite of Stassfurth. He has examined the corresponding minerals of Kalusz, in Gallicia, and has found in carnallite, thallium and rubidium, but no caesium. Sylvine yielded thallium, but neither caesium nor rubidium. In kainite, thallium, rubidium, and caesium were absent. He concludes that sodium, lithium, and caesium occur together, whilst potassium, rubidium, and thallium form a distinct group, and that the last element should be included among the alkaline metals, as is maintained by Böttger, Mendeleeff, and others.

Cosmos les Mondes.

No. 15, August 11, 1883.

Bichromatisation.—Dr. Laujorrais.—The author recommends potassium dichromate for disinfecting cesspools, sewage, dissecting-rooms, &c., and considers it likely to be of great service in the treatment of diseases due to microbia.

Nos. 16 and 17, August 18 and 25, 1883.

These numbers contain no chemical matter.

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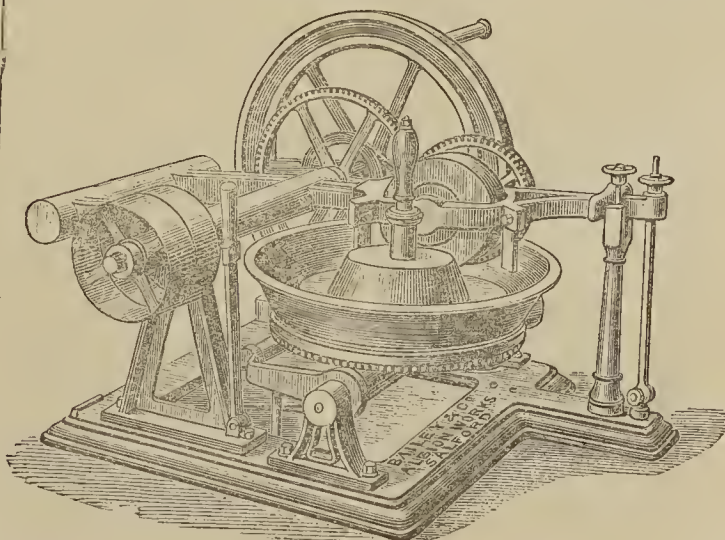
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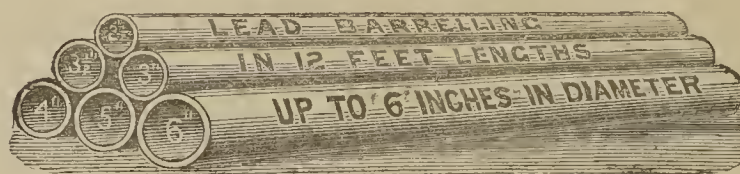
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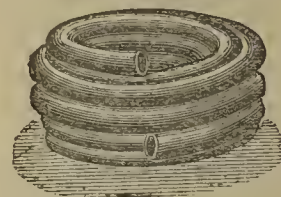
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METHODS FOR COKING COAL AND RECOVERING THE BY-PRODUCTS.*

By WATSON SMITH, F.C.S., F.I.C.

THERE are various forms of plant for coking coal for the production of coke for metallurgical purposes, which may be classed as follows:—

1. Those accompanied with no utilisation or recovery of the by-products.
2. Those utilising the by-products merely as fuel, burning them, but recovering no by-products.
3. Those recovering the by-products and utilising as fuel the gaseous portion thereof.

Representative Systems neither utilising nor recovering By-products.	Representative Ovens consuming Tar Vapours and Gases as Fuel, for Heating their Walls and Bottom Beds, either or both.	Representative Ovens adapted for recovering By-products and utilising the Gas for Fuel.	
		A.	B.
I. The Meiler or mound. II. The beehive oven.	I. Appolt oven. II. Coppée oven.	Admitting air, and so partial combustion of the coal. — Jameson's oven.	Closed ovens. Destructive distillation. — Knab's oven. *Pauwells and Dubochet's. Pernolet's. Simon-Carvès's.

* Illuminating gas was made at Paris by this method, the tar and gas-liquor being recovered.

There are many other forms of oven, but I have only referred here to the representative systems, and I do not propose to enter into any detailed description of the development, construction, and working of all these ovens, but after the briefest sketch of the development from the more elementary forms, of the two most improved modern representative forms, to deal with these as regards the results obtained more especially, in more detailed fashion.

MEILER, OR MOUND.—The Meiler, or mound, closely resembles the well-known Meiler constructed for producing charcoal from wood, and needs no further remark save that the coke obtained is good and freer from sulphur than oven-coke, owing to the desulphurising action of the steam derived from the moisture at the base of the Meiler. The ground at the base of the Meilers for this reason is often kept damp in order that moisture may be absorbed. The Meiler coke is not so hard as oven-coke.

BEEHIVE OVEN.—The Beehive oven, which yields a metallurgical coke that can scarcely be surpassed, wastes all the gas and by-products generated, and the verdict by almost all English coke makers till recently has been that it is impossible to condense by-products without sustaining a depreciation of the quality and value of the resulting coke. Even now there are many who will not hear of any attempt at recovery of by-products being made, regarding such recovery as an unerring blow struck at the quality of the coke.

APPOLT OVEN.—Although, however, the collection and recovery of condensed by-products were deemed inadmissible, yet to some of the more far-sighted there seemed no reason why these by-products, containing

latent, vast possibilities of heating effect, should all pass up the oven chimneys as half-burnt gases and smoke, disfiguring the landscape and damaging vegetation—and hence the invention and construction of the forms of oven named after Appolt and Coppée. The principal feature in the construction and working of the former is that, instead, as in the Beehive oven, of the flames and half-burnt gases and smoke passing up a flue through the centre of the dome into a main flue, and so passing to the chimney, the hot gases and tar vapours distilled from the coal in the closed oven pass into numerous circulating side flues, surrounding and enveloping the inner case of the oven. Into these side flues air is admitted, its admittance being suitably regulated, and so perfect combustion and a high heating power are secured. The bottoms of the Appolt ovens are composed of movable plates secured by screw and cross-bar, and thus the coke produced is readily removed. This oven yields an excellent coke.

COPPÉE OVEN.—The Coppée oven resembles Appolt's, but the gases and vapours descend from an aperture in the upper part of the oven by vertical flues heating its sides, and supplied with air by means of suitable apertures to insure complete combustion to flues passing under the oven bottom, which the flames strongly heat. A main flue then often carries the hot gases to do further duty in heating steam boilers, &c., before they finally pass to the chimney.

It will now be necessary to proceed to consider the development of two of the best systems of ovens now existing with combined recovery of by-products, from certain of those forms of ovens which were originally combined with no appliance or apparatus for recovering the by-products. I mean the Jameson oven developed from the Beehive form, and the Simon-Carvès from the Knab's oven.

JAMESON'S COKE OVEN.—Jameson modifies the common beehive oven in the following way:—He substitutes for the usual solid floor of the oven on which the coal is carbonised, a floor of perforated quarles supported on sleeper walls, these perforations being connected with a short vertical flue underneath the floor, from which a pipe passes at right angles towards the hydraulic main situated some little distance from the ovens. A branch thus proceeds to this main from each oven in a battery of ovens, and just before entering the main the down-pipe from each branch is furnished with a cock for regulating or stopping the exhaustion on the oven at discretion—this exhaustion being carried on as is usual in gas-works. It is stated that the "heating gas produced can be conveyed to a distance and used in heating, and raising steam"—this gas not being employed in aiding the coking process itself. Now, if the results be good, we have in this arrangement of Jameson's at least promise of no great expense in construction, for Mr. Jameson proposes simply to put in his new floors to beehive ovens, and then simply add the condensing and aspirating apparatus. Whether this can be done effectively or not, or whether, having pulled up the old floors and further modified the dome, it will not prove best to renovate the whole oven, to prevent air being too liberally sucked in, will be a question to be settled by practical experience. If Mr. Jameson's estimate of cost be correct, and this cost do average £20 per oven for perforated floor, piping, and proportion of condensing scrubber and exhauster, then it cannot be said this cost is excessive; but the question now to be answered is, What is to be the outcome? What does this tar consist of, and of what value are the constituents? What yield of ammonia is obtained? &c.

1. The coke is good, and is readily accepted by ironmasters, but so is the Beehive coke.

2. As regards the ammonia, this is collected and condensed as ammoniacal liquor, which I am told contains a good deal of the ammonia as sulphite. This must be due to the effect of the air drawn into the Jameson oven. Jameson says he can obtain ammoniacal liquor equal to a production of from 5 to 15 lbs. of ammonium sulphate per

* A Paper read before the British Association, Section B, Southport Meeting.

ton of coke, = 3 to 9 about, per ton of coal. A wide difference truly, and betokening some want of certainty.

3. The tar, as it was at first called, is now, I observe, termed "oils," and Jameson states that he obtains six to fifteen gallons of tar per ton of coal coked. As to this tar, various reports have got abroad. In the *Journal of the Society of Chemical Industry* it has been represented in one case as consisting merely of paraffins, liquid and solid, and in another as containing no aromatic compounds applicable to the manufacture of colours. Now neither of these statements is quite true, although in part so. Though benzene is quite absent in the Jameson tar, yet in admixture with paraffins, both very small quantities of toluene and larger quantities of xylene are present. I have obtained their nitro-products. Now benzene, toluene, and, I believe, xylene, have been found in the Scottish shale spirit produced in the works of the Young Paraffin Light Co. This I proved at least to be the case in 1868. But these aromatic hydrocarbons were mixed in the shale spirit with bodies of about the same vapour tension, belonging to the olefiant gas series, and the attempt to convert them into their corresponding nitro-derivatives resulted in the production of bodies yielding most acrid and pungent fumes, resembling those of acrolein. Besides rendering the operation of nitration intolerable, the acrid bodies were not easily removed from the nitro-benzene and its homologues. But in the spirit from the Jameson oils the bodies present belong to the marsh-gas series mainly, and hence the aromatic hydrocarbons present might be safely nitrated, and the paraffins afterwards removed by steam from the crude nitro-products. The unfortunate circumstance is that there is so little of this benzene series present, and the representative member (benzene) was quite absent from all samples I have yet examined.

Lubricating or Burning Oils.—The chief bulk of the Jameson tar, having a specific gravity of 0.960, consists of oils boiling between 250° and 350° C., from which on cooling no crystalline substance separates. These oils I have tested as regards their burning qualities in lamps, and as regards lubricating value, and I find them of little value for burning, and of but secondary value as lubricants. One singular feature about them is that they are quite devoid of "blueness" or fluorescence. If these oils find their way into the market, I would give a timely warning to all those who are buyers of vegetable and animal oils, viz., cease to rely solely on the test of "blueness" or fluorescence of the oils you examine, as a proof of the presence in them of mineral oils!

Paraffin.—But a considerable proportion of oils distils over above 350° C., viz., from somewhere about 400° to the point at which pitch remains in the retort, and these oils do separate paraffin scale, though not so much as could be desired, and the paraffin wax obtained has a high melting-point, viz., 58° C. It is characteristic of the solid paraffin obtained (of course in small quantity) from certain normal coal-tars, especially those obtained from Wigan cannel, that this paraffin possesses a very high melting-point. The highest melting-point of the paraffin wax made by the Scottish shale distillers is about 52° C.

Phenols.—If the crude oils boiling between 200° and 300° C. be treated with caustic soda-lye, and the phenols extracted in the usual way, a fairly large proportion of a peculiar series of phenols of increasing boiling-points is obtained in the crude extract, certain of these phenols resembling the constituents of the creosote of wood-tar. A mere trace of carbolic acid was found, but more of the cresols, and by far the largest bulk of the constituents of the crude phenol, distils at from 250° to 300° C. The latter fraction boiling at about 300° is a resinous substance perfectly soluble in caustic soda, to which it communicates a red colour.

Certain of these phenols yield blue and red colours with alkalis, but of no stability or value. These coloured alkaline salts remind one of the coloured salts of eupittonic acid, the phenol-like acid derived by the oxidation of Reichenbach's wood-tar pittacal.

Neither naphthalene nor anthracene is present even in traces in Jameson's coke-oven tar. The fact that the specific gravity of this tar is less than that of water is a circumstance sufficient of itself to indicate that it belongs to the class of tars obtained by the distillation of coal at lower temperatures. I think that Jameson's coke-oven tar offers a fine field of research to the scientific chemist, and that his labours may develop valuable fruit in a commercial sense, as well as for science; but I do not consider this tar at present, looking at its heterogenous nature, a very inviting subject for present commercial speculation, in view of the possibility of getting the far more valuable real coal tar as a coke-oven by-product, with its colour-yielding and purely aromatic constituents.

I have here to thank Mr. H. L. Pattinson, jun., of Felling, on the Tyne, for his kindness in supplying me with tar from the Jameson process, with which process he has been experimenting, also for furnishing me with a large supply of the crude phenols.

CLOSED OVENS.—We will now turn to the next species of ovens, viz. the closed oven, in which a purely destructive distillation takes place. The best of this class is decidedly the Simon-Carvès oven, and I think I can show that it does its work perfectly. The Simon-Carvès oven is a lineal descendant, so to speak, of the Knab's oven, which was the first coke-oven with which a process for the recovery of by-products was combined. The ovens of Pauwells and Pernolet were intermediate steps in the right direction. In what direction, then, did these steps tend? In the direction of a more elevated temperature, and this advance involved continual improvements in construction, so as to secure the attainment of increased distilling temperatures. In the Simon-Carvès oven employed at Messrs. Pease's work at Crook by Darlington the temperature attained is 2200°, but in the recently improved recuperative ovens a temperature of 3000° may be reached at the point of actual combustion. Although Knab's oven, first started in 1856, and furnished with side and bottom flues for the combustion of the oven gases, but not recovering by-products, was afterwards modified for such recovery by M. Carvès himself, and was thus a step in the right direction, it was merely so in being a closed oven, not as regards the temperature, for the tar yielded was not yet of the right kind. Of the still more improved methods of Pauwells and Dubochet used at the Paris gasworks, and of Pernolet, we read, as regards the tars produced, in the treatise on Coal-tar Distillation by my friend Professor Lunge, of Zürich, these tars "differ to some extent in composition from the ordinary gas-tar, and quite naturally, since in the case of the former the temperature has been much lower." The temperature being "much lower" means the introduction of paraffins into the tar, and the paraffins mean the comparative ruin of any anthracene that may be formed. It means, moreover, the probable absence of naphthalene in the tar, and admixture with the members of the benzene series of lower paraffins or olefines. It was thus M. Carvès who first (by a modification of Knab's oven) devised and constructed a coke oven designed for the recovery of tar and ammonia.

I have had the opportunity some two or three months ago, of inspecting the Simon-Carvès ovens and plant at work in Crook, at Messrs. Pease's West Collieries, and Mr. Dixon, the manager, kindly supplied me with a quantity of tar and coke obtained in the process. The ammonia liquor is of good strength, 6°–7° T, and is sold to a tar distiller in Middlesbrough, on the usual terms for gas liquor. Let us now examine the plans of the Simon-Carvès oven, and see by what means the high temperature already referred to is attained. These ovens are joined to exhausting, condensing, and scrubbing apparatus, quite similar to that found in the system employed in gas-works.

I observed on inspecting the tar-well at Messrs. Pease's work, that its walls, and the inside of the man-hole edge,

were lined with a sublimate of naphthalene, and the tar possessed the smell and appearance of the tar from ordinary gas retorts. Now this sublimed naphthalene indicates that the condensing and cooling power are very deficient, and as I expected, the density of the tar was high, for no doubt much of the uncondensed benzene and toluene had been carried off with the gas and burnt in the ovens.

The Tar.—The Carvès tar is quite different, both in appearance and specific gravity, from Jameson's. Its specific gravity is 1.20, and it is black and thick, and smells quite differently from the Jameson product. The former sinks, therefore, at once in water, whilst the latter floats on its surface. In composition the tar from the Carvès ovens closely resembles the tar produced in the large London gasworks, *i.e.* it is exceedingly rich in naphthalene and anthracene, but less rich than some tars, *e.g.* the Lancashire tars, in benzene, toluene, xylene, and carbolic acid, but these it contains as richly as any London tar. It is, moreover, quite free from paraffins. This great difference in the Simon-Carvès tar from Jameson's is due to the fact that in the production of the former a close oven, a very high temperature, and a rapid distillation are adopted, just as is the case in the gasworks. I said that a good deal of benzol in the Simon-Carvès process as carried on at Pease's, must pass with the fuel gases into the oven-furnaces again, and so be burnt. Now I should like to indicate what might be done further, in addition to improved condensation, and no doubt will be done, and so place the Simon-Carvès process quite beyond the reach of its rivals.

MELLOR'S PROCESS FOR RECOVERING BENZOL AS NITRO-BENZOL.—A process has been patented recently by Mellor, of Patricroft, for abstracting the benzol from gas, by washing the latter with strong nitric acid in an earthenware tower filled with broken glass. The nitro-benzol formed is an oily body, in which benzol itself is soluble, and so the acid mixed with nitro-benzol from one washing, and strengthened with sulphuric acid, can be passed down the tower again and again, and no benzol is lost through insufficiency of acid, for when the acid is exhausted, the nitro-product produced dissolves out benzol. This benzene (the toluene is quite easily nitrified) can be then removed by steaming, with subsequent condensation. Thus both benzene and nitro-benzol might be obtained, though Mellor merely refers to "benzol."

DAVIS'S PROCESS.—Mr. G. E. Davis, of Manchester, has patented a process for refrigerating coal gases, and washing the gases so refrigerated, with refrigerated heavy coal-tar oils, by which he extracts all the benzol present. By a subsequent wet steam distillation, the benzol is recovered, may be rectified, and sold.

Let either of these or similar processes be grafted on to the Simon-Carvès process—say at Messrs. Pease's—and let them extract and manufacture their own tar products and sulphate of ammonia, and extract the rich store of anthracene in their tar for the alizarin manufacturers, and I think they will be tempted by the profitable results ensuing to speedily convert all their numerous batteries of beehive ovens into Simon-Carvès ovens, and so turn what are at present waste gases and smoke into hard cash.

But now comes the question as to the coke. Attempts formerly made to obtain valuable tar by-products in variously constructed ovens generally resulted, as we have said, in the obtaining, according to report, bad coke for blast-furnace use. How is it to be explained, then, that the coke obtained in the Simon-Carvès process is as coherent, solid, and massive as could be desired, and yet the tar is identical with that obtained in gas-works retorts, where a coke is made of little value to the ironmasters?

In the Simon-Carvès ovens, a very large charge, $4\frac{1}{2}$ tons of coal, is used, and this is piled up to a considerable height, some 6 feet or so. The thickness of the mass is also considerable (about 19 inches), but not so great that the heat of the oven sides cannot penetrate it with sufficient ease to give a uniform product. Now as in the retorts of the gasworks, the mass soon attains a caked condition, but being thicker, and hence being penetrated more slowly,

it attains a more thoroughly caked or pasty stage than the thinner mass on the gas-retort bottoms can do before beginning to set again, in the incipient coked stage of the process. But further, in the Simon-Carvès ovens, the superincumbent weight of a pasty mass of some 6 feet in height introduces a new and important factor in the production ultimately of a hard, solid article—the semi-fused fuel maintained in a soft condition to a late stage by the high temperature of the Simon-Carvès ovens becomes thus pressed by its own weight, and sinking down, gives, on cooling, a hard, solid mass. Finally, from so huge a charge as $4\frac{1}{2}$ tons, and charred under a certain gaseous pressure, and with a thickness of material proportionately considerably larger than is found in gas retorts, I believe that during the escape of the tar vapours from the decomposing mass, a portion of these must suffer almost complete coking, the pores of the mass becoming thus filled up, the yield of coke increased, and more solidity being thus conferred upon it—another function of the high temperature of the ovens.

In the ordinary metallurgical coking process with the beehive oven, and in a less degree with the Jameson process, we have a kind of partial combustion or oxidation effected in which the oxygen of the air admitted or drawn into the ovens plays a part, the hydrogenised portions of the coal being to some extent burnt away, but in the closed Carvès ovens purely a case of destructive distillation ensues. It is not to be greatly wondered at that the appearance of the coke obtained in Simon-Carvès ovens is somewhat different then from that obtained in the beehive and Jameson oven, not possessing the silvery glance of the latter, though at least being fully as solid, hard, and compact. Mr. Dixon, Messrs. Pease's manager, told me moreover that some of their customers who had taken both kinds of coke (the beehive and the Simon-Carvès) from them, preferred the latter, the new kind, and wished to be supplied with it entirely.

I feel quite sure that the process of M. Carvès, so intimately associated with the oven of his development and construction, will be the coking process of the future, and that anything done to extend its right appreciation and make known the great possibilities it offers will be a service to this country.

THE DIRECT UNION OF NITROGEN AND HYDROGEN.*

By H. BRERETON BAKER.

IN two papers read before the Chemical Society in 1880, and in one read before the Royal Society in 1881, Mr. Stillingfleet Johnson announced that he had caused the two elements nitrogen and hydrogen to unite directly, and that he had discovered that nitrogen could exist in two allotropic modifications. His views did not meet with general acceptance among chemists. It was thought that a little more of the light of experiment might be thrown upon this subject. This I have endeavoured to do.

I will, with your permission, first describe briefly the mode of experiment adopted by Mr. Johnson:—

The hydrogen was generated by the action of sulphuric acid on zinc; the nitrogen, by warming an aqueous solution of ammonium nitrite. The two gases were passed through a wash-bottle of silver nitrate solution, and through two of strong sulphuric acid. They then bubbled through some Nessler's solution contained in a set of Liebig's bulbs, were passed over red-hot platinum sponge contained in a piece of combustion tubing, and, lastly, through another set of Liebig's bulbs containing Nessler's solution. The production of ammonia in the tube containing the spongy platinum would be recognised by the

* A Paper read before the British Association, Section B, Southport Meeting.

colouration of the Nessler in the second set of bulbs, while that in the first remained colourless. Now Mr. Johnson observed the production of comparatively large quantities of ammonia. He was able to estimate it by bubbling the gases through standard sulphuric acid, and found it amounted to about 6 m.grms. an hour. He tried to get the same result by using nitrogen obtained from the air by passing it over red-hot copper. No ammonia was produced! He explained this by supposing that nitrogen can exist in two allotropic modifications, one of which is capable of direct union with hydrogen, and the other not. He supposed that the nitrogen from the air had lost its activity by being exposed to a red-heat.

In the second paper read before the Chemical Society he expresses some misgivings as to the purity of his "active" nitrogen. It is well known that towards the end of its decomposition ammonium nitrite gives off considerable quantities of oxides of nitrogen. These, if not removed, would enter into reaction with hydrogen under the influence of spongy platinum, forming ammonia. Mr. Johnson accordingly modified his apparatus. The nitrogen, obtained by the decomposition of ammonium nitrite, was passed through four absorbers containing ferrous sulphate solution. At this point a three-way tube was inserted, and the hydrogen (previously purified by passing through a solution of silver nitrate) was introduced into the apparatus. The mixed gases were passed through two wash-bottles containing ferrous sulphate, through one of alkaline pyrogallate, through one of sulphuric acid, through the first Nessler's solution, over the heated platinum sponge, and through the second Nessler's solution.

By using these absorbers of nitric oxide the production of ammonia was diminished to 3 m.grms. an hour. This experiment demonstrates, therefore, that *half* the ammonia produced in the first experiment was due to the presence of oxides of nitrogen. I venture to think that my experiments will show that the whole of it may be accounted for in the same way.

Mr. Johnson suggested that the nitrogen of the air lost its activity by being exposed to a red-heat. I attempted to prepare active nitrogen by exposing cold phosphorus in a bell-jar suspended in a deep vessel of water. When the absorption of oxygen was complete the bell-jar was lowered into the vessel of water, and the nitrogen driven into a gas-holder. The hydrogen was prepared by the action of dilute sulphuric acid on zinc. It was freed from arsine and stibine by passing it through two cylinders filled with marbles which were soaked in a strong solution of potassium permanganate. The two gases were passed together through three wash-bottles of pyrogallate of potash, through one of sulphuric acid, through tube I. of Nessler's solution, over the heated platinum sponge, and through the second tube of Nessler. In this apparatus there was no possibility of the entrance of the oxides of nitrogen. Three experiments were made. In two of them the gases were passed for an hour and a half, the platinum sponge being heated to low redness. In the third the gases were passed for two hours, the platinum being heated for an hour and a half to a dull redness by a Bunsen's lamp, and during the last half hour the gas blowpipe was applied to get a higher temperature. In none of these experiments was there the slightest difference perceptible between the colours of the Nessler's solutions I. and II. It may be concluded, therefore, that nitrogen obtained from the air by absorption of the oxygen with phosphorus does not unite directly with hydrogen under the influence of platinum sponge.

Several other experiments were made with a simpler kind of apparatus. The spongy platinum was placed in the shorter arm of an inverted U tube. About 20 c.c. of air, contained in this tube, were allowed to stand over a solution of potassium pyrogallate for eighteen hours. When the absorption of oxygen was complete the tube was transferred to a dish of pure water, and the solution of pyrogallate contained in the tube allowed to diffuse

into the water. This process was repeated until the contents of the tube were colourless. A pellet of metallic sodium was held beneath the open end of the tube until the volume of hydrogen added was about thrice that of the nitrogen originally contained in the tube.

The part of the tube containing the platinum sponge was heated. In all the experiments a decrease of volume of the gases was noticed. This seemed to indicate chemical union. By means of a bent pipette some Nessler was introduced into the tube, and owing to the peculiar bend in the tube the test solution could be shaken in the gas without wetting the platinum sponge. No colouration of the solution was produced; it was therefore considered that the decrease in volume was due to occlusion of hydrogen by the platinum. In another series of experiments the mixture of nitrogen and hydrogen was obtained by warming the platinum sponge in a mixture of 3 volumes of hydrogen and 1 volume of air. In no case was any indication of ammonia observed.

Allow me now to point out where Mr. Johnson's error arose. After getting a purely negative result with this apparatus, I introduced a flask of silver nitrate between the third bottle of pyrogallate and the bottle of sulphuric acid. The gases were passed for fifteen minutes. No alteration took place in Nessler I.; a distinct precipitate formed in Nessler II. The introduction of the nitrate of silver had caused the formation of ammonia.

On reference to Mr. Johnson's apparatus it will be seen that, after using elaborate precautions to ensure the freedom of his nitrogen from oxides of nitrogen, he introduces the same impurity with the hydrogen. He has, however, three absorbers of nitric oxide between the bottle of nitrate of silver and the platinum sponge. To ascertain whether these would be sufficient to remove the source of error, I arranged the following experiment:—Hydrogen, purified as before by potassium permanganate, was passed through a solution of silver nitrate, through three bottles of saturated solution of ferrous sulphate, through one bottle of strong sulphuric acid, through Nessler's solution I., over heated platinum sponge, and through Nessler's solution II. The gases were passed for three-quarters of an hour, on three separate occasions, and in each case a distinct brown colouration was observed in the second Nessler's solution.

In addition, the solution of nitrate of silver was blackened, silver having been deposited, and the first wash-bottle of ferrous sulphate showed a darkening in colour, presumably from the absorption of nitric oxide. It may be considered either that the absorbers are not sufficient to remove all the nitric oxide produced by the decomposition of silver nitrate, or, as seems more probable, some other oxide of nitrogen, not absorbable by ferrous sulphate, is produced in that decomposition. In either case we see where the error of Mr. Johnson's experiments lies. The ammonia was produced by the action of hydrogen on an oxide of nitrogen. We may therefore come to the conclusion that hydrogen does not unite directly with nitrogen under the influence of heated spongy platinum, and, as far as our present evidence goes, nitrogen does not exist in two allotropic modifications.

Joint Action of Potassium Dichromate and of the Halogens upon Organic Matters.—M. l'Abbé Godefroy. In this preliminary memoir the author states that instead of oxidising organic bodies with a mixture of potassium dichromate and sulphuric acid he has substituted for the latter reagent chlorine, bromine, and iodine. He has obtained not merely oxidised organic derivatives, but oxyhaloid derivatives and certain compounds of chromium. On treating aniline in this manner with iodine he obtains mauveine, a small quantity of a beautiful red matter; long, slender, crystalline needles, extremely flexible, and an insoluble precipitate of a fine black, containing chromium.—*Bull. de la Soc. Chim. de Paris.*

AN APPARATUS FOR RAPID GAS ANALYSIS.*

By ARTHUR H. ELLIOT.

IN many manufactories and metallurgical works it is often of great service to be able to make rapid analyses of the gases resulting from various operations, as these analyses serve to control the operations and indicate the progress of the processes. This is especially true for iron and steel works, where a knowledge of the composition of the gases from a furnace is an index of the character of the changes going on inside the furnace. Such rapid analyses are also often needed in gas-works. To meet this requirement of technical works, many methods have been devised and various ingenious forms of apparatus have been constructed. But all the appliances used for this purpose have been based upon the principle of absorbing the various gases in a mixture by liquid reagents. Of the many methods of using liquid reagents that of Orsat is probably the best known, and the one that has been most used. In this apparatus the gas, after being measured, is made to pass into vessels containing the liquid reagents, and so

out with water in such a manner that the gas is not lost. Raoult performed this treatment of the gases and washing out of reagents in a graduated tube with two stop-cocks, one at each end; one of the stop-cocks was surmounted with a funnel to introduce the fluids. But the whole affair was not easily managed, and the gases were submitted to an unnecessary amount of washing while removing the excess of reagents used.

Wilkinson modified this method, and devised a very simple and useful apparatus, in which the clumsy manipulations of Raoult were overcome by using a tube with one stop-cock above, the lower end of the tube dipping into water in another tube of much larger diameter. By this means the gases could be treated with liquid reagents, introduced through a funnel attached to the stop-cock above; and by introducing or removing water from the outer tube the gas could be measured at atmospheric pressure. To facilitate the removal of liquids from the outer tube, the latter has a stop-cock attached below. But, as in the apparatus of Raoult, the gases are submitted to an unnecessary amount of washing when water is introduced to remove the reagents. This washing

FIG. 1.

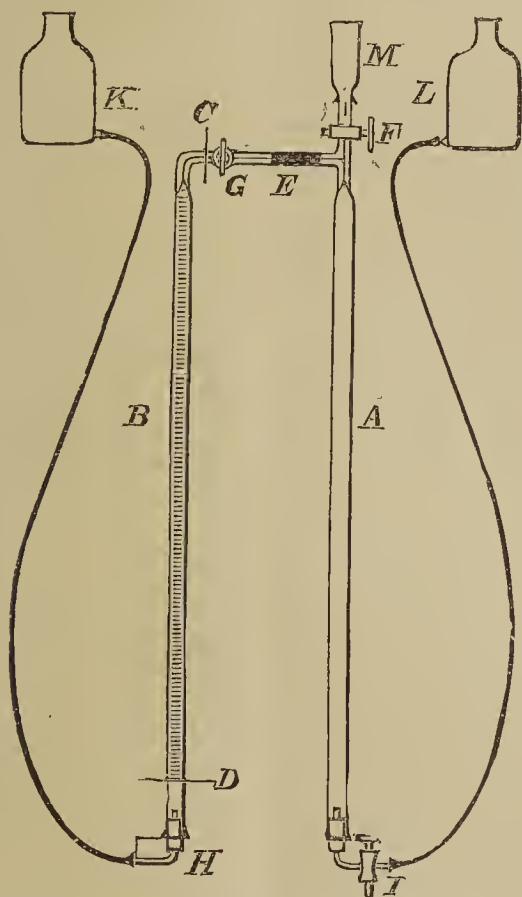
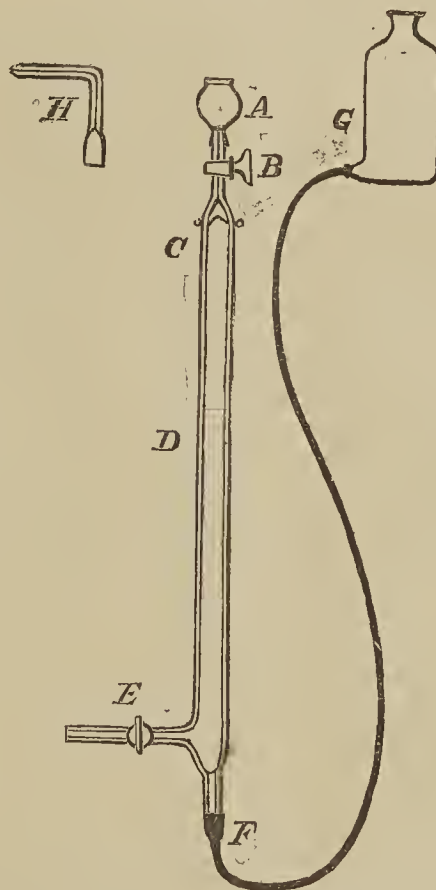


FIG. 2.



arranged as to expose a large surface, wet with the reagent, to the mixture of gases. If time is of little value, this apparatus works very well, but it is too slow in its action to be desirable for use in technical works. One great objection to the apparatus itself is the number of stop-cocks attached to the various parts of it. These stop-cocks become incrustated with the various reagents and refuse to turn without great trouble; and any force applied to them is apt to cause a fracture, which ruins the apparatus for further work until the damage is repaired.

Instead of passing the gas into a vessel containing the chemical reagents, Raoult† put the reagent into a tube containing the gas. In treating a mixture of gases with several reagents, it is necessary to remove one reagent before adding another. This is accomplished by washing

becomes very important in many cases. For example take the case of illuminating gas. We introduce potassic hydrate solution to remove the carbonic acid, then potassic pyrogallate to remove oxygen; and now we must wash out the alkali before adding bromine to absorb the illuminants. To do this, much water is needed, and this large quantity of water will wash out some of the illuminates, often as much as two per cent.

To overcome this difficulty of excessive washing, I have devised the apparatus which is the subject of this paper. In this process, the gas is removed from the absorbent liquid and measured in another vessel, without washing.

The apparatus is shown in Figure 1. The tube A is of about 125 c.c. capacity, whilst B, although of the same length, holds only 100 c.c. from the point D, or zero, to the mark on the capillary tube at C, and is carefully graduated in 1-10th c.c. The attachments to these tubes below are seen from the drawing, except that the stop-cock I is

* From the *Annals of the N. Y. Academy of Sciences*, vol. ii. No. 12, 1883.

† F. M. Raoult *Compt. Rendus*, 1876, 844.

three-way and has a delivery through its stem. The bottles K and L hold about a pint each. The tubes A and B are connected above with one another, and also with the cylindrical funnel, M, by a series of capillary tubes about one millimetre in diameter inside. There is a stop-cock at G and another at F, while the funnel M, which holds about 60 c.c., is ground to fit over the end of F above. At F is a piece of rubber tubing uniting the ends of the capillary tubes, which are filed square to make them fit as closely as possible.*

In beginning the analysis of a mixture of gases, the stem exit of the three-way cock I is closed by turning it so that L and A are connected through the rubber tubing; the stop-cocks F and G are opened, and water is allowed to fill the apparatus from the bottles K and L, which have been previously supplied.

When the water rises in the funnel M, and all air-bubbles have been driven out of the tubes, the stop-cocks F and G are closed, the funnel M removed, and the tube delivering the gas attached in its place.† By now lowering the bottle L slowly, and simultaneously opening the stop-cock F, the tube A is nearly filled with gas, and the stop-cock F is closed. The tube delivering the gas is removed, the funnel M replaced, the bottle L raised, the bottle K lowered, and by opening the stop-cock G, the gas is transferred to the graduated tube B.

The bottle K is now adjusted so that the level of the water in it is the same height as the zero-mark D on the graduated tube. By means of the bottle L, the gas is adjusted to the zero-mark D in the graduated tube, and the stop-cock G is closed.

The excess of gas in A is expelled by opening the stop-cock F and raising the bottle L. The gas remaining in the capillary tube between C and the vertical part is disregarded, or its value may be ascertained and an allowance made; but usually it is too trifling to be worth notice.

Having measured the gas, it is now transferred by means of the bottles K and L into the tube A, and the fluid chemicals added by placing them in the funnel M and allowing them to flow down the sides of the tube A slowly, care being taken *never* to let the fluids run below the level of the top of the vertical tube in the funnel. It is best to have a mark on the outside of the funnel at least three-fourths of an inch above the top of the level of the vertical tube, and never to draw the fluid down below this point.

Having treated the gas with the chemical, it is transferred by means of the bottles to the tube B, to be measured. If the chemical gets into the horizontal capillary tube, the passage of a little water from the bottle K will remove it, before transferring the gas. When the gas residue is in B, and the fluid of A has been adjusted at the mark C on the horizontal tube, the stop-cock G is closed, the bottle K is lowered till the level of liquid in it and in the tube B are the same, and the reading is then made. The tube A is now filled with the chemical just used as absorbent, and water; by turning the stem of the three way-cock I, so that it communicates with A, and is open below, and by also opening the stop-cock F, the contents of the tube can be run out, and water added through the funnel M to clean the tube for a new absorption. When the tube is clean, by turning the stop-cock I, so that A and L are connected, the water is forced into A, and the whole is ready to receive the gas in B for new treatment.

In using the apparatus, the chemicals are added in the following order:—

1. Potassic Hydrate (1 in 20) to absorb carbonic acid. If illuminating gas is under examination, a very little of the reagent will be necessary, and it is better to use a

* The height of the apparatus can be diminished by having bulbs at the points of union of the capillary tubes and the absorption and measuring tubes A and B; such bulbs being of about 25 cubic centimetres capacity, and the graduations continued downwards from the bulb on the tube B. Making the funnel spherical also reduces the height of the apparatus.

† A tube of the same construction as is shown in the explosion-burette figure can be attached to the end of the stop-cock, and thus facilitate the attachment of the rubber tubing.

solution of potassic hydrate of four times the above strength, in order to prevent washing out of the illuminants. For traces of carbonic acid, and also for the determination of sulphurous acid and sulphuretted hydrogen, special methods are necessary.

2. Bromine, to absorb illuminants. This is added to some water placed in the funnel. It is best handled with a very small pipette, since only a few drops are necessary. Add it till the tube is filled with its vapour; then absorb the vapour with potassic hydrate used for carbonic acid.

3. Potassic Pyrogallate, to absorb oxygen. Solution of potassic hydrate (1 in 8), containing about three per cent of pyrogallic acid.

4. Cuprous Chloride, to absorb carbonic oxide. This is a solution (1 in 4) in concentrated hydrochloric acid. After using it, and *before* transferring the gas to the measuring tube, a little water is added to absorb the acid vapours.

By this method, a mixture containing carbonic acid, oxygen illuminants, and carbonic oxide, can be analysed in from twenty to thirty minutes, according to the amount of practice the operator has had with the apparatus.

Compared with Orsat's process, the work can be done with the above-described apparatus in one-fourth the amount of time, and with identical results.

The water used in the apparatus should have the same temperature as the room in which the analysis is made; and by careful handling, little or none of the chemicals get into the bottle L. When working in a warm place, the tube B should be surrounded with a water-jacket to prevent change of volume in the gas while under treatment.*

Having added the above absorbents, the residue of gas may consist of hydrogen, marsh-gas, and nitrogen; and for the determination of these I have devised a simple form of explosion-burette, shown in Figure 2. It consists of a burette, D, of heavy glass, graduated in tenths of cubic centimetres, and holding 100 cubic centimetres to within about two inches of the lateral tube, E, below; the upper end is closed by a stop-cock, B, over which fits a funnel, A, in the same manner as in the apparatus described above. The graduations on the tube are made so that the stop-cock is the zero point, and the 100 mark is below, near the lateral tube E.

Into the upper end of the burette, at C, are fused two platinum wires for an ignition spark. At the lower end of the burette, the glass is drawn out to receive, at F, a piece of soft rubber tubing about three feet long, which in turn communicates with the aspirator bottle, G. Care should be taken that the opening of F and the tubulature of the bottle, G, are not smaller than the bore of the rubber tubing used to connect them, since any contraction would prevent the cushioning of the explosion when the spark is passed.† The bent piece, H, is ground to fit over the stop-cock, B, when the funnel, A, is removed, and facilitates the transfer of the gases from the absorption-burette before described, as it is easier to slip a piece of rubber tubing over the smooth end of H than over the ground end of the stop-cock, B. The stop-cock, and also the fitting, H, have capillary tubing of about one millimetre bore. The stop-cock at F, and its tube attaching it to the burette, are of ordinary size, about 1-8th to 3-16ths of an inch.

The operation of the burette is as follows:—

The funnel is removed from the absorption-burette of the previously described apparatus, and a fitting exactly like H is substituted for it. The gas should be previously transferred to the measuring tube of the absorption-apparatus. The explosion-burette is placed in a vertical position in a stand near the absorption-apparatus. The bent tube on the upper stop-cock of the absorption-apparatus is now

* Whenever possible, it is better to collect the gas in tubes and transfer it to the apparatus in a position away from sources of heat.

† It is also most important that the clamp holding the burette should not hold too tightly, as pressure upon the glass will cause a fracture on exploding the gases. It is better to use a spring clamp.

attached to a piece of rubber tubing long enough to reach to the corresponding bent tube of the explosion-burette. The aspirator-bottle, G, is filled with water, and by raising it and opening the stop-cock, B, and closing E, the explosion-burette is filled with water, including the bent tube, H, fitted over the end of the stop-cock, B. By a similar movement of the aspirator-bottle attached to the absorption-apparatus, the corresponding bent tube and its rubber tube are also filled with water. Care should be taken that the water completely expels all air-bubbles from the capillary tubes and the rubber tube. The explosion-burette is now attached to the absorption-burette by means of the rubber tubing already filled with water, by slipping this rubber tubing over the bent tube of the explosion-burette; taking care to exclude all air-bubbles when making the attachment. To facilitate the connecting of the bent tubes and the rubber tubing, the ends of these tubes should be drawn out so that the rubber tubing will easily slip over them.

Having connected the explosion-burette with the absorption-apparatus in the manner described above, we are now ready to transfer the gas-mixture for the explosion. For this purpose, the three-way cock of the absorption-apparatus is turned so that the bottom of the absorption-tube is closed. By now opening the stop-cocks above on the absorption-apparatus, and also on the explosion-burette, and by moving the aspirator-bottles, any desired quantity of gas can be transferred from the absorption-apparatus to the explosion-burette. When the proper quantity (about 18 or 20 cubic centimetres is sufficient) of gas has been transferred, the stop-cocks of the absorption apparatus are closed, also the stop-cock of the explosion burette. By means of the aspirator-bottle, G, the level of the water is adjusted so that the gas is at atmospheric pressure, by bringing the level of the water in the aspirator-bottle to the same height as that in the explosion-burette. This gives the correct reading of the quantity of gas used. We now have to mix this gas with the proper quantity of oxygen to cause an explosion on passing a spark through the wires, C. This oxygen is admitted through the stop-cock, E,—most conveniently from a gas-holder or cylinder under pressure. Having added the proper quantity of oxygen (about equal in volume to the gas used),* the correct volume of the mixture thus obtained is read off in the same manner as that of the original gas. But before the final reading is made, the burette is removed from the stand, and by a few movements from vertical to horizontal positions, the gases are mixed, and any oxygen that collects in the tube, E, is removed to the bulk of the gases in the upper part of the burette. Having taken the final reading of the mixture, the upper part of the tube is tapped slightly to dislodge any water adhering to the platinum wires, and the spark from an induction coil is passed between them, the aspirator-bottle being below the level of F, in order to expand the mixture. A sharp click is now heard, and the tube is allowed to stand so that the heat of the explosion may pass away before reading the contraction. When the tube is cool, the reading is taken by lifting the aspirator-bottle as before. This reading gives the contraction, and by removing the bent tube and replacing the cylindrical funnel, A, the carbonic acid resulting from the explosion may be absorbed with potassic hydrate, as in the absorption-apparatus, the readings always being taken after adjusting the levels of the liquids in the burette and the aspirator-bottle.

When removing the bent tube and attaching the cylindrical funnel, care should be taken that the air in the capillary tube of the stop-cock is removed. This is accomplished by attaching the funnel, putting into it a little potash solution, and then inserting a piece of thin copper wire into the capillary tube of the stop-cock; by this means the air-bubbles are readily removed. Like the absorption-apparatus previously described, this explosion-

burette is intended for rapid work where some accuracy is sacrificed to the saving of time. It has the great advantage that the explosion can be made over water—the long piece of rubber tubing acting as a cushion to the shock. I have used this burette for over a year, and with the most satisfactory results. It is only intended to be used with mixtures of gases, containing hydrogen, marsh-gas, and nitrogen,—the other ordinary constituents being determined in the absorption-apparatus.

The following formulæ are used in calculating the results of the explosion of a mixture of hydrogen, marsh-gas, and nitrogen, or hydrogen and nitrogen.

Let C = Contraction. D = Carbonic Acid: then,—

$$\frac{2C - 4D}{3} = \text{Hydrogen}$$

and D = Marsh-gas.

In the case of hydrogen and nitrogen the above formula becomes simply—

$$\frac{2C}{3} = \text{Hydrogen.}$$

These calculations give the quantities of the above gases found in the number of cubic centimetres of gas-residue used in the explosion; it is of course necessary to calculate these upon the total amount of residue left in the absorption-burette. The nitrogen is found by adding together the figures for the other constituents of the gas and subtracting their sum from 100.

The subjoined table illustrates the character of the mixtures of gases that can be analysed with the above described apparatus.

Carbonic acid	..	..	3.4	7.3	0.0	0.7
Illuminants	..	..	—	—	6.3	15.6
Oxygen	..	..	0.0	1.0	0.3	1.5
Carbonic oxide	..	..	40.2	29.8	6.0	8.5
Hydrogen	..	..	44.9	55.8	—	13.0
Marsh-gas	..	..	—	0.0	—	33.8
Nitrogen	..	..	11.50	6.1	—	26.9

With care, and a little practice with the apparatus, results are obtained within a few tenths of a per cent. of the truth, and this at an immense saving of time over the older methods of analysis—the results answering every ordinary purpose in gas and metallurgical works. After some practice, a complete gas-analysis, using the absorption-apparatus and explosion-burette, can be made in less than an hour.

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NOTICES OF BOOKS.

General Properties of the Phenols (Propriétés générales des Phénols). By Dr. JULES VILLE. Paris: G. Masson.

We have here a monograph of the phenols. The author arranges them in four orders; the phenols of the benzol group, those derived from the styrol group, the derivatives of diphenyl, and of phenanthrene.

Their physical properties are next discussed and an account is given of their "syntheses" and their formation from the benzols. The author next treats of the chemical properties of the phenols, distinguishing such as are due to the aromatic nucleus upon which the phenolic hydroxyl is fixed, those which result from the phenolic function itself, and those which consist in coloured reactions still unexplained. In a fourth chapter he considers the analogies between the phenols and the tertiary alcohols. He comes to the conclusion that the lines of separation which have been established between the phenolic function and the alcoholic function are disappearing one by one, whilst all new data tend to connect—it may almost be said to identify—these two classes of compounds in one and the same function.

* If the gas mixture contains little or no nitrogen, it is better to add half the volume of oxygen and one volume of atmospheric air, to moderate the force of the explosion.

In his last chapter Dr. Ville reviews the physiological action of the phenols. Their poisonous action is a most interesting fact if we consider that at least one of them, ordinary phenol, the most poisonous of the group, is normally present in the human organism, and must, indeed, be viewed as a product of the pancreatic digestion of the albumenoid matters and of their decomposition in the intestine. This single fact overthrows the so-called qualitative theory of poisons, which asserts that whatever is poisonous in large doses is poisonous also in the smallest, the difference being merely in the extent of the injury.

This thesis may be pronounced a clear and serviceable monograph.

Pocket Book for Chemists and Metallurgists (Taschenbuch für Chemiker und Hüttenleute). Issued by the Association "Hütte." Berlin: Ernest and Korn.

This work is edited by the "Hütte,"—an association of chemists and Metallurgists—and does not bear the name of any author. We are told that some years ago the wish was felt for a work analogous to the "Engineers' Pocket Book," and which should give in a condensed form the most important methods, rules, and results of chemical science and metallurgical art.

The plan thus conceived has been carried out with great care, accuracy, and thoroughness. The "Pocket Book" is in fact an exceedingly convenient manual of reference, not merely for the student, but especially for the practical specialist.

The first and second sections of the book treat of mathematics and mechanics, giving a variety of tables and formulæ.

In the third we find physical information; rules for taking the specific gravities of solids; determination of the specific gravity of fluids by means of the pycnometer, of communicating tubes, of Mohr's balance and the areometer. Then follow directions for finding vapour densities, tables of the specific gravities of the elements and their salts; of sundry solids technically important; of metals in various conditions and of kinds of wood, and of gases and vapours. Next we come upon a comparison of hydrochloric acid at different specific gravities, according to Uhr and Roth; similar tables for nitric acid according to Kolb, and for sulphuric acid by Bineau, Kolb, and Kohlrausch; for aqueous sulphurous acid according to Scott, and for acetic acid by Oudemans; Gerlach's tables for solutions of tartaric and citric acid; Geilach's table for liquid ammonia, for potassa, soda, alkaline carbonates, sodium chloride, potassium, ammonium, barium, calcium, magnesium, zinc and tin chlorides; similar tables for the more important bromides, iodides, nitrates, sulphates, potassium chromates, lead acetate, ferro- and ferricyanides. Then follow tables of the solubility of salts in cold and boiling water. Next we find thermometric tables, reduction of the degrees of the mercurial thermometer to those of the air thermometer, the expansion of solids, of liquids and gases, boiling- and melting-points; boiling-points of saturated solutions, freezing mixtures; tension of watery and mercurial vapours, heat liberated by combustion; and specific heats.

The purely chemical portion of the book begins with Mendelejeff's periodic classification of the elements, followed by a table showing their symbols, valences, atomic, molecular, and combination-weights, equivalents, specific and atomic heats. Next come an abstract of the fundamental laws of chemistry, a table of the molecular weights and percentage composition of a number of the most important bodies; rules for preparing and testing reagents; the behaviour of bodies with reagents in the moist way; a systematic course of qualitative analysis; tables or blow-pipe analysis, both qualitative and quantitative; instructions for volumetric analysis; tables for calculating the results of quantitative analysis, and a summary of the methods of ultimate organic analysis.

We have next a section on spectroscopic analysis, with an account of the absorption spectra of the principal dyewares of blood, and of solutions of the earths and metals.

Then follow mineralogical tables giving the chemical composition, crystalline form, cleavage, hardness, specific gravity and form of occurrence of each species.

The last and most extensive section is devoted to chemical technology. The work here treats first of sulphur, then of the manufacture of sulphuric acid and nitric acid, the potash industry of Stassfurt, the salt-trade, the production of hydrochloric acid, salt-cake, soda, the ammonia-soda process, chloride of lime, Weldon's and Deacon's processes for generating chlorine, soaps, ammonia and ammonium salts, alum prussiate, ultramarine, potassium chlorate, borax and boracic acid, iodine, bromine, the dry distillation of wood and coal with their products; the manufacture of ether, aniline, chloroform, glycerin, oxalic and phthalic acids, resorcin, the sulphocyanides, stearine, tartaric acid, carbon disulphide, explosives, artificial manures; the technology of glass and earthenware, of paper, beet-root, sugar, and betose, the starch manufacture, beer, alcohol, acetic acid and vinegar, glue, animal charcoal, phosphorus; the gas manufacture; the art of dyeing, including the inorganic and organic colouring matters. Metallurgy is next discussed with a particular notice of the processes of industrial gas analysis.

In an appendix are given the weights and measures of different countries; an abstract of the German patent law, adulteration law, and laws regulating the respective duties of employers and servants.

We think the impression produced on the mind of every one who examines this book carefully will be astonishment at the quantity of useful matter which is here compressed together. In the laboratory of any chemical manufactory it will save, in a short time, many hours and much trouble employed in turning over works of reference.

It may, perhaps, be maintained, on the principle of the division of labour, that there are certain portions which concern the engineer rather than the industrial chemist.

CORRESPONDENCE.

THE PROBLEM OF LIFE.

To the Editor of the Chemical News.

SIR,—Mr. Griffith's communication in the *CHEMICAL NEWS*, vol. xlviii., p. 179, emphasises a question which is frequently put by chemists of the rising generation—Where are we to look for a plain statement of the reasonable ideal of our science in regard to life?—And it does so by prominently reproducing, as worthy of unqualified adoption, the utterances of two of the most distinguished of our scientific men, upon this important theme; whereas, I venture to say, they offend in point of looseness and dogmatism in so obvious a manner, that no one of ordinary clearness of vision could do otherwise than question them. Let them speak for themselves. Prof. Schorlemmer says: "If ever chemists should succeed in obtaining albuminous bodies artificially, it will be in the state of living protoplasm, perhaps in the shape of those structureless beings which Hæckel calls the *Monera*." And again: "*The enigma of life can only be solved by the discovery of the synthesis of an albuminous compound. All attempts hitherto made for the purpose of producing spontaneous generation have (therefore) necessarily failed.*"

The italics and arrangement of the sentences are my own.

Prof. Huxley says, and the statement is taken by Mr. Griffiths to be generally equivalent to the preceding:—"It must not be supposed that the differences between living and not living matter are such as to bear out the assumption that the forces at work in the one are different

from those which are to be met with in the other. The phenomena of life are all dependent upon the working of the same physical and chemical forces as those which are active in the rest of the world."

What Prof. Huxley means, if I might venture to interpret, is that matter with its quantum of energy is the same all the world over, whether in living or not living bodies. But *can* it be asserted that there is no agency operating in living matter, subject, of course, to this conditioning essence of all matter, distinct from the forces at present known to us as energising in inanimate matter?

It is not my intention to enter into this controversy. These things have been spoken *ex cathedra*; can they be maintained, I would ask, upon the common human platform of enquiry into the problem of life?

As I have no desire to obtrude my personality into these questions, I retire behind the convenient symbol

X.

SELENIUM IN HYDROCHLORIC ACID.

To the Editor of the Chemical News.

SIR,—With regard to the yellow colour of raw hydrochloric acid, allow me to say a few words.

There is another substance besides ferric chloride that causes the colouration: this is selenium.

A sample of tower acid was sent here for examination, from a neighbouring alkali works, where pyrites is used. It was of a yellow to a yellowish-red colour, and had a slight red deposit at the bottom of the bottle. On treating a little of the acid with potassic chlorate, it became quite colourless. This might lead to the supposition that the colour was due to organic matter. To settle this point a fresh portion of the sample was taken, washed, and a little sulphurous acid added; a copious red precipitate was obtained, indicating the presence of selenium. A portion of the precipitate was heated on platinum foil; it gave the characteristic smell, gave no luminous flame, and left no residue. The non-luminous flame showed the absence of organic matter. When the precipitate was filtered off, the filtrate was colourless, also showing the absence of organic matter. A carboy of tower-mud was then obtained, the selenium in which was oxidised by means of potassic chlorate into solution, and the residue filtered off. The selenium was then re-precipitated by means of stannous chloride as a flocculent, easily settling mass, and after washing was drained on a filter.

No doubt the pyrites was a source of the selenium. As selenious acid, it was carried into the chambers, and by means of the vitriol into the salt-cake pot, and hence to the condensers, together with the hydrochloric acid gas. The sulphurous acid gas, a little of which is always contained in the pan gas (formed by the action of the sulphuric acid on the pan), reduces the selenious acid to selenium (the cause of the slight red deposit in the bottle).

This proves that the colour of the raw hydrochloric acid was due to the selenium, and that iron is not always the cause.—I am, &c.,

W. B. HART.

Ardwick Bridge Chemical Works,
Manchester, Oct. 9, 1883.

The Liquefaction of Oxygen and the Solidification of Carbon Disulphide and Alcohol.—S. v. Wroblewski and K. Olszewski.—The authors obtain a temperature low enough for the congelation of carbon disulphide and alcohol, and for the liquefaction of oxygen by allowing liquid ethylene to boil in a vacuum. The temperature produced depends on the perfection of the vacuum. The lowest point reached by the authors was -136° . At -135.8° oxygen liquefies under a pressure of 22.5 atmospheres. Carbon disulphide solidifies at -116° , and absolute alcohol at -130.5° .—*Journal für Praktische Chemie*.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvi., No. 12, September 17, 1883.

Qualitative Detection of Manganese in Commercial Zinc, in Zinc Ash, and Calamine, and Detection of Bismuth in Commercial Lead by means of Electrolysis.—A. Guyard.—The author has found that the zinc of commerce contains almost invariably appreciable traces of manganese. Zinc ash, a mixture of zinc oxide, and finely-divided metallic zinc, is much richer in manganese than the metal. There is also in this ash an accumulation of iron, copper, lead, and other non-volatile impurities of zinc. To detect the presence of manganese it is necessary to saturate the ash or calamine with dilute sulphuric acid (equal vols. of the mono-hydrated acid and of water). The mixture is let stand a little, without filtering, and submitted to electrolysis, taking care to use a negative pole of copper or brass, and a positive pole of platinum. In a few moments the positive pole is surrounded with a splendid rose-violet halo of permanganic acid, whilst the negative pole is covered with a brilliant layer of metallic zinc. For detecting manganese in commercial zinc a rather large quantity of the metal is melted in a crucible at the lowest possible temperature so as to allow ash to form; the crucible is skimmed, and the manganese is sought for in the scum as above directed. For the detection of bismuth, if we electrolyse a rather strong solution of pure zinc sulphate with a negative pole of platinum and a positive pole of lead, after a time the lead becomes thickly coated with lead peroxide; if the metal contains bismuth, this dissolves, and is precipitated with the zinc at the negative pole. The copper, always present in commercial lead, traverses the liquid in the same direction, so that if the precipitated zinc is dissolved in dilute sulphuric acid, there remains a black sponge, in which it is easy to detect the presence of copper and bismuth by known methods.

Journal für Praktische Chemie.

New Series, Vol. xxviii., Part 1, No. 12, 1883.

Contributions to a Knowledge of the Oxides of Manganese.—Odin T. Christensen.—An extensive and very elaborate memoir, not capable of formal abstraction. The author shows that pure manganese oxide is so decomposed by dilute nitric acid that exactly half the manganese enters into solution, whilst the other half remains as manganese peroxide. Acetic acid has very little action upon ignited manganese oxide, the strength of the acid being indifferent. Ignited manganic oxide is the less attacked by acetic acid the higher the degree of concentration. Manganic oxide, $Mn^{III}_2O_3$, is rightly classed with the oxides of the iron-aluminium group.

Chemico-critical Passages.—H. Kolbe.—A criticism of the views of Prof. Baeyer on isatine, in which the author asks what is the exact meaning of an "internal anhydride."

Mercury Fulminate.—A. Ehrenberg.—Aqueous hydro-sulphocyanic acid does not act upon mercury fulminate as does hydrochloric acid, but there are formed mercury sulphocyanide, ammonium sulphocyanide, and carbonic acid. Ammonium and potassium sulphocyanides decompose mercury sulphocyanide in the same manner as the alkaline chlorides.

Liquefaction of Nitrogen and Carbon Monoxide.—S. v. Wroblewski and K. Olszewski.—These gases are less readily liquefied than oxygen, resisting a temperature of 136° and a pressure of 150 atmospheres. But if the

pressure is gradually released, though so as not to fall below 50 atmospheres, both nitrogen and carbon monoxide are completely liquefied.

Antiseptic Properties of Carbonic Acid.—H. Kolbe.—The author showed last year that carbonic acid has a remarkable power of preserving beef from putrefaction. He finds now that this observation was anticipated in Hermstädt's "Systematischer Grundriss der Allgemeinen Experimental Chemie," p. 162, a work published in 1791.

Preparation of Nitro-phenetol.—A caution against heating the sodium salts of the two nitro-phenols in an autoclave with aqueous solutions of the salts of the ethereo-sulphates.

Justus Liebig's Annalen der Chemie,
Band 220, Parts 1 and 2.

Investigations on Hydroxylisation by Direct Oxidation.—R. Meyer.—The author concludes that "tertiary hydrogen atoms," and as it appears, only such, can be converted into hydroxyl by direct oxidation.

Molecular Volumes of Liquids.—R. Schiff.—In this memoir, which is to be concluded, the author summarises the results obtained by Kopp, Thorpe, and Brühl. He then proposes a method for determining the specific gravities of liquids at their boiling-points, the requisite apparatus being described and figured. By this method he has found the molecular volumes of a number of fluids, chiefly hydrocarbons.

Communications from the Laboratory of the University of Würzburg.—These consist of a paper by A. K. Miller on pyrocatechin-carbonic acids and iodo- and oxy-salicylic acids; a memoir by J. Heckmann on dinitro-phenyl-acetacetic ester; a discussion of the influence of the asymmetric carbon atom upon the ethans derived from active amylic alcohol, by F. Just; and a paper by K. Bauer on certain transformations of the tertiary alkyl-iodides.

Communications from the Chemical Laboratory of the University of Lemberg.—These comprise memoirs by Dr. Lachowicz on certain hydrocarbons of the methan series and their derivatives, and on the constituents of Gallician petroleum, which appears to contain an entire series of aromatic hydrocarbons, the methylated derivatives of benzol being especially present.

On Maltose.—A. Herzfeld.—The author examines the composition of the salts of maltose, and raises the questions whether it is a simple anhydride of glucose; whether, like saccharose and glucose, it is capable of forming double salts with certain haloid compounds; and whether maltose, when oxidised by means of bromine, and the product decomposed by treatment with silver oxide, forms dextronic or gluconic acids, or some other acid.

Cosmos les Mondes.

No. 1, September 1, 1883.

This number contains no chemical matter.

No. 2, September 8, 1883.

Sleeping with the Head Northwards.—A number of phenomena are brought forward to prove the influence of terrestrial magnetism upon animal life.

Researches on the Spheroidal State of Bodies.—M. Boutigny.—A notice of the fourth edition of M. Boutigny's book. The author is said to have anticipated Deville's discovery of dissociation, and to have maintained on physical grounds, as far back as 1842, that Mars must have at least two satellites.

Combination-heats of the Soluble Compounds of Lead.—Dr. D. Tommasi.—The author gives the combination-heats of lead bromide, nitrate, formiate, acetate,

and glycolate, as determined experimentally, and as calculated according to the law of the thermic constants of substitution. The author calls attention to the discrepancy presented by the formiate and the acetate, in which the theoretical results are too low.

New Researches on Nitrogen Iodide.—A. Guyard.—From the *Comptes Rendus*.

No. 4, September 22, 1883.

This number contains no chemical matter.

Revue Universelle des Mines, de la Metallurgie, &c.,
Tome xiii., No. 3, 1883.

Petroliferous Strata of Central Europe.—L. Pied-bœuf.—Topographical descriptions and geological speculations on the origin of the petroleum beds.

The Inflammable Nature of the Gases evolved in the Diffusion of Beet-roots.—L. Chevron.—The gases in question consist largely of hydrogen.

NOTES AND QUERIES.

* * Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Recovery of Sulphur from Spent Oxide.—Could any of your readers give me any information or instructions how to recover the sulphur from spent oxide used in the manufacture of coal-gas, by washing it with bisulphide of carbon? and also give a brief description of the plant necessary to produce it on a large scale. I have searched various books, but cannot find any reference to it. Are there any publications to be got treating upon this subject?—A. S.

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THE CHEMICAL NEWS.

VOL. XLVIII. No. 1247.

THE INVESTIGATION BY MEANS OF PHOTOGRAPHY OF THE ULTRA-VIOLET SPARK SPECTRA EMITTED BY METALLIC ELEMENTS AND THEIR COMBINATIONS UNDER VARYING CONDITIONS.

Drawn up by Professor W. N. HARTLEY, F.R.S.E., &c.

The Disappearance of Short Lines.—It was shown in a former report of this committee (Southampton Meeting), that the spectra of metallic solutions were the same as those from metallic electrodes, line for line, in most cases even short and weak lines being reproduced. The principal difference observable in the two spectra was a lengthening of the short lines when spectra were taken from solutions, so that discontinuous lines became long or continuous lines.

A few instances of short lines disappearing have also been noticed, but such disappearances occurs only when the lines are so short, mere dots in fact, that no solution can contain a quantity of the metal sufficient to yield an image of them, unless the rest of the spectrum be greatly over exposed. Certain very short lines in the spectrum of zinc are an example of this. Very short lines in the spectrum of aluminium were not reproduced by solutions of the chloride unless the solutions were highly concentrated. It may thus be seen that the quantity of metal present in the compound thus determines the presence of these lines.

The Lengthening of Short Lines.—It was remarked that in certain cases metallic electrodes showed a different spectrum according to whether the spark was passed between dry or wet electrodes. Thus it was pointed out that when iridium electrodes are moistened with calcium chloride, discontinuous lines, which are very numerous in this spectrum, become continuous, and on further examination into this matter it has been found that even moistening with water has the same effect. Hence the supposition of which there seemed some possibility, but no proof, that a chloride of the metal was formed was found to be untenable. The very short lines in the spectrum of zinc were lengthened by the action of water upon the electrodes. It has now been proved beyond doubt that this peculiar variation in the spectra is caused by the cooling action of the water upon the negative electrode, which in effect is the same as a strengthening of the spark, since by heating the electrodes a reverse action is the result.

Alterations in the Spectrum of Carbon.—As already stated in the previous report, graphite electrodes have been generally employed for the purpose of producing spark spectra from solutions. A portion of the work in connection with this subject included an investigation of the effect of water and of saline solutions in varying the spectrum of carbon. It will of course be readily seen that, as carbon is capable of combining with oxygen and nitrogen, that different spectra might be obtained by making one or other of these gases the atmosphere surrounding the electrodes, but it is not so easy to explain why graphite points should give two different spectra in air when dry, and a third spectrum when moistened with water, the same spark conditions being maintained. Three such spectra have

been photographed, but without the aid of maps their peculiarities are not capable of exact description. The maps which were drawn were presented to the Royal Society together with a communication on this subject three months since, so that they are not at present available. It may be said, however, that the difference between the spectra taken from dry electrodes in air consists in the omission of a certain number of the less refrangible lines, which have undoubtedly been identified with carbon.

Spectra of the Non-Metallic Constituents of Salts.—A long series of experiments has been made with the subject of determining the non-metallic elements which are capable of yielding spark spectra when in combination with the metals. Chlorides, bromides, iodides, sulphides, nitrates, sulphates, selenates, phosphates, carbonates, and cyanides yield nothing. On the other hand, solutions in hydrochloric acid of arsenites, arseniates, and antimonates yield spectra of arsenic and antimony respectively. Borates and silicates in solution yield very characteristic spectra of the non-metallic constituents, but if the solutions be prepared from sodium salts the lines of the metal do not appear in the case of borates, and only the strongest line of sodium ($\lambda=3301$) can be observed in the spectrum of silicates, even when concentrated solutions are used. These are the first spectra of boron and silicon obtained from metallic salts. Their lines are the following:—

BORON. Wave-lengths.	SILICON. Wave-lengths.
3450.1	2881.0
2497.0	2631.4
2496.2	2541.0
	2528.1
	2523.5
	2518.5
	2515.5
	2513.7
	2506.3
	2435.5

In Messrs. Liveing and Dewar's* map of the carbon spectrum, and in the list of the carbon lines, and in the map of the iron spectrum,† a number of lines are given which are absent from the photographs of the spectrum of graphite published in the *Transactions of the Royal Dublin Society* and in the *Journal of the Chemical Society*.‡ Many hundreds of spectra taken between graphite poles have failed to show a trace of these lines, and as the spectra have been photographed under very varying conditions it is scarcely likely that the lines in question are really carbon lines. They have now been identified with the spectrum of silicon. The following are their wave lengths:—

LINES FROM THE CARBON SPECTRA (Liveing and Dewar).		SILICON (Hartley).
Spark.	Arc.	Spark.
—	2881.1	2881.0
2541.0	—	2541.0
2528.2	2528.1	2528.1
2523.6	2523.9	2523.5
2518.7	2518.8	2518.5
2515.8	2515.8	2515.5
2514.0	2514.1	2513.7
2506.3	2506.6	2506.3
	2478.3	—
	2434.8	2435.5

From this it appears that in the spectrum of the arc, carbon yields but one line in the ultra-violet, wave-length 2478.3.

The Spectrum of Beryllium.—The researches made for the purpose of this report have been useful in furnishing

* Report of Committee consisting of Professors Odling, Huntington, and Hartley (Secretary). Presented to the British Association, Southport Meeting.

* *Proc. Roy. Soc.*, vol. 33, p. 403.

† *Phil. Trans.*, vol. 174, Part 1, 1883.

‡ Vol. 41, p. 90.

evidence leading to a determination of the probable position of beryllium amongst the elements. It has been proved that the spectrum of metallic solutions are identical with those of the metals themselves, and it is therefore obvious that characteristic spectra may be obtained from concentrated solutions of nitrates or chlorides when metallic electrodes are not procurable just as is the case with visible spectra. It was resolved to photograph the spectrum of beryllium as obtained from its chloride in order to observe the character of its lines and the manner of their grouping. The following were the lines observed:—

SPECTRUM OF BERYLLIUM.

Wave-lengths.	Description.
3320·1	Strong, sharp.
3129·9	Very strong, extended.
2649·4	Strong, sharp.
2493·2	Strong, sharp.
2477·7	Strong, sharp.

The first two numbers differ slightly from those given in the *Journal of the Chemical Society*,* but they are believed to be the more accurate. The previous measurement of the lines of beryllium were two given by Thalén† with wave-lengths 4487 and 4575, and two lines very close together given in Cornu's Map of the Solar Spectrum, wave-lengths 3130 and 3130·4. It will be observed that in the spark spectrum only one line corresponding to the first of the solar lines is observed, viz., that with wave-length 3129·9. There is probably a difference in this case between the arc and the spark spectra, because there is no difficulty in distinguishing between two lines differing by 0·4, are under various conditions two lines have never been observed at this point in the spark spectrum. On the other hand such differences are by no means unusual.

Regarding the views held by Emerson Reynolds, Nilson, and Pettersson and Brauner on the subject of beryllium, there may be a want of harmony in detail, but they at least agree in assigning a value not greater than 13·8, and not less than 9·2 to its atomic weight. The former number implies that the metal is a triad, the latter that it is a dyad. In the former case it must belong either to the series of elements of which aluminium, gallium, and indium are members, or to a sub-group of rare earth metals to which yttrium and scandium belong. In attempting to accommodate the element with a position in either series we are met by a serious difficulty, namely, that not only is the atomic weight not in keeping with the periodic law (a point which cannot be discussed here), but its spectrum is altogether different from the spectra typical of either class. There is a periodic variation in the spectra of the elements as well as in their atomic weights and chemical properties, and we cannot put the periodic law out of mind in considering the position of beryllium. Now the spectra typical of the triad group, of which aluminium and indium are the first and third terms, consist of three pairs of lines harmonically related, the intervals between the individuals of each pair increasing with increased refrangibility of the rays in each spectrum, while the intervals between the individuals in each pair in different spectra increases with the increase of atomic weight. The interval between each pair of lines contains an isolated ray. As the atomic weight of beryllium is less than that of aluminium it should have a spectrum in which the same grouping appears, but the intervals between the pairs of lines should be shorter, and the individuals of each pair should be closer together. The lines of beryllium are not characteristically grouped like those of aluminium and indium; it cannot therefore belong to this series of elements. If we attempt to classify beryllium in a manner which accords with Nilson and Pettersson's views‡ the

elements scandium and yttrium, with atomic weights 44 and 89 respectively, must yield spectra typical of the series, and the similarity between the spectra of the two metals beryllium and scandium must be as close as that between scandium and yttrium. Now Thalén's spectra of scandium and yttrium, though both totally unlike the spectrum of any other element, have many characters in common.* Both spectra contain highly characteristic groups of lines in the orange and yellow regions, the lines or bands degrading towards the red, and the number of lines which have been measured are no fewer than 103 and 90 respectively. From these two spectra, that of beryllium is entirely different, as well in the character and grouping as in the number of the lines. Of the remaining rare earth metals at present known cerium is a tetrad, didymium is a pentad, and lanthanum a triad; their spectra are quite dissimilar from that of beryllium. In consideration of these facts it is impossible to classify the spectrum of beryllium along with the spectra of the rare earth metals of the triad group.

Let us now consider the question of the dyad groups. On the assumption that beryllium has an atomic weight of 9·2, there is no difficulty in placing it at the head of the second series of elements, in which position it stands in the same relation to the sub-groups magnesium, zinc, cadmium, and calcium, strontium, barium, that lithium occupies with regard to sodium, potassium, rubidium, and copper, silver, mercury. Its position is also similar to that of boron and of carbon, in relation to the triad and tetrad metals.

The spectra belonging to magnesium, zinc, cadmium, have a very definite constitution; they consist of—1st, a single line; 2nd, a pair of lines; 3rd, three to four groups of triplets; 4th, a quadruple group; 5th, a quintuple group of lines. The intervals between the individual lines in the different groupings increases with the increase in the atomic weights of the elements. In fact these spectra present a considerable addition to the body of evidence in support of the view that elements whose atomic weights differ by an approximately constant quantity, and whose chemical properties are similar, are truly homologous bodies, or, in other words, are the same kind of matter in different states of condensation. Their particles are vibrating in the same manner but with different velocities.

In the spectra of the metals calcium, strontium, and barium, successive pairs of lines are a strong feature, in addition to which there are some other groups in the spectrum of barium. The individuals of each pair are separated by smaller intervals, the more refrangible the lines, and by longer intervals the higher the atomic weights. It cannot be said that the spectrum of beryllium is precisely similar in constitution to either of these groups of elements, which it should be if it strictly belonged to one of them. There is some slight resemblance in character to the spectrum typical of the calcium group, beryllium showing two pairs of lines, the individuals of the first or less refrangible pair being separated by a greater interval than those of the second pair. It is a spectrum analogous to that of lithium, having but few lines and no striking resemblance to the elements which follow in the series, because it stands at the head of two sub-groups. Hence it has been concluded that beryllium is the first member of a dyad series to which probably calcium, strontium, and barium are more strictly homologous than magnesium, zinc, and cadmium. It is to be understood that this is a conclusion drawn from one view only, and is open to correction or modification when fresh facts shall have been discovered, but so far the views of Professor Emerson Reynolds and Dr. Brauner are maintained by these spectrum observations, for beryllium is shown to be quite out of place among the triad elements, including those belonging to the rare earths.

* P. 31, June, 1883.

† Watts's "Index of Spectra."

‡ Proc. Roy. Soc., 1880, vol. 31, p. 37.

* Kongl. Svenska Akademiens Handlingar, vol. 12, p. 4; also Comptes Rendus, vol. 91, p. 45.

SEPARATIONS OF GALLIUM.

By M. LECOQ DE BOISBAUDRAN.

Separation from Tantallic Acid.

WHEN galliferous tantallic acid has not been strongly ignited, it may be obtained in a soluble state by fusion with ammonium bisulphate and treatment of the cold mass with water. In the opposite case it is treated with potassium bisulphate at a red heat and taken up in water, which deposits almost all the tantallic acid in an insoluble form; this is then melted with ammonium bisulphate. The author gives the five following methods:—

1. The sulphuric solution is diluted with water and boiled. The precipitate contains the tantallic acid and merely a very small quantity of gallium, which is eliminated by acting upon the tantallic acid again with ammonium bisulphate and re-precipitating by boiling the dilute solution. Two or three such operations generally suffice to eliminate all the gallium. But as the boiled sulphuric liquids are very acid, sensible traces of tantallic acid escape precipitation. After filtration the liquids are therefore partially neutralised, leaving them only moderately acid, and boiled again. The small quantity of tantallic acid, rich in gallium, which is thus collected, is treated separately; the gallium is extracted by successive fusions with ammonium bisulphate, and the slightly acid solutions are boiled.

2. The substance is melted with potassium bisulphate at a red heat, and treated with boiling water, which dissolves the salt of gallium, and leaves the tantallic acid as an insoluble compound. Three operations are necessary to deprive the tantallic precipitate of all gallium, but the filtrates still retain some slight traces of tantallic acid, which are recovered by boiling, after quasi-neutralisation, and treating the precipitate as described in the former paragraph.

3. When the proportion of gallium is slight we may utilise the solubility of this oxide in ammonia. The clear tantal-gallic solution is poured into a large excess of dilute ammonia, and filtered after repeated stirrings. The precipitate of tantallic acid retains more or less gallium, and it is therefore again fused with ammonium bisulphate, and treated with ammonia. Three or four operations generally suffice to remove the last traces of gallium.

4. The sulphuric solution is mixed with tartaric acid and a salt of manganese, and supersaturated with ammonia. In this mixture ammonium sulphide gives a precipitate which carries down the gallium, and but little tantallic acid. It is washed very well, and the gallium is extracted by known methods. This method is very suitable for determining slight quantities of gallium in presence of much tantalum. The manganese sulphide must be filtered without delay, as in the course of a day tantallic acid is deposited spontaneously, and becomes mixed with the precipitate.

5. The sulphuric solution is mixed with tartaric and arsenious acids, and an excess of acid ammonium acetate, and is then treated with hydrogen sulphide. If the liquid is turbid it may be clarified by a short application of heat before passing in the hydrogen sulphide. Little or no tantallic acid remains in the galliferous arsenic sulphide.

Separation from Niobic Acid.

1. The niobic acid is precipitated by boiling the dilute sulphuric solution, following exactly the process No. 1, given above, for the separation of gallium and tantalum. Although the precipitation of niobic acid is more complete than that of tantallic acid in solutions of the same acidity, the niobic solutions should nevertheless be partially neutralised.

2. The substance is attacked with potassium bisulphate at a red heat; taking the precautions indicated under No. 2 for tantalum.

3. The gallium is carried down with manganese sulphide, taking the precautions indicated under the method No. 4 for tantalum.

4. The method with arsenious acid is carried out exactly as directed for tantalum.

5. Ammonia may serve for separating gallium from niobic acid. Niobic acid is not as absolutely insoluble in ammonia as is the tantallic acid.—*Comptes Rendus.*

RECENT ANALYSES OF THE ASH OF FUCUS VESICULOSUS AND FUCUS SERRATUS.

By A. B. GRIFFITHS, M.A., Ph.D., F.C.S.,
Medallist in Chemistry and Botany, &c.

THE following are recent analyses of the ash of two common kinds of sea-weeds found on our shores:—

Fucus vesiculosus (Bladder Wrack).

	I.	II.
Potash	14.91	14.89
Soda.. .. .	11.54	11.52
Calcium oxide	10.46	10.49
Magnesium oxide	7.29	7.33
Ferric oxide	0.59	0.60
Sodium chloride	25.99	25.97
Silica	1.45	1.44
Sulphuric acid	25.36	25.30
Phosphoric acid	2.37	2.38
	99.96	99.92

Fucus serratus.

	I.	II.
Potash	4.99	5.01
Soda.. .. .	18.98	18.90
Calcium oxide	14.75	14.79
Magnesium oxide	10.39	10.38
Ferric oxide	0.50	0.52
Sodium chloride	23.96	23.94
Silica	1.50	1.52
Sulphuric acid	20.89	20.90
Phosphoric acid	3.93	3.92
	99.89	99.88

Bromsgrove, Sept. 3, 1883

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING SEPTEMBER 30TH, 1883.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the Water Examiner, Metropolis Water Act, 1871.

London, October 4th, 1883.

SIR,—We submit herewith the results of our analyses of the 210 samples of water collected during the past month, on the several days indicated, from the filtered water reservoirs of the seven London Water Companies taking their supply from the Thames and Lea.

It will be observed that we have on this occasion collected our samples not as usual from the mains, but from the reservoirs of the several Companies before its entry into the mains.

In Table I. we have recorded the analyses in detail of

samples, one taken daily, from September 1st to September 30th inclusive. The purity of the water, in respect of organic matter, has been determined by the Oxygen and the Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples submitted for analysis.

Of the 210 samples of water submitted to examination, the whole, with the exception of five samples which were recorded as "very slightly turbid," were clear, bright, and well filtered.

The water supplied to London during the month of September continues to be of most excellent quality. With comparatively few exceptions, the samples submitted were characterised by a remarkable absence from other than blue colour. In respect to aëration and freedom from organic matter, the waters were unimpeachably excellent.

In Dr. Frankland's report to the Registrar-General, on the quality of the water supplied to the metropolis during the month of August, it is stated that the so-called "organic impurity" of the river derived water was from $2\frac{1}{2}$ to $2\frac{3}{4}$ times as great as that of a particular well-water adopted by himself as a standard. As usual, however, it is not pointed out, *per contra*, that the so-called "previous sewage contaminations" of the standard well-water is more than twice as great as that of the Thames and Lea derived waters,—a comparison for the significance of which we would refer to the foot-note appended to our August report. Neither is it pointed out, though shown by Dr. Frankland's own figures, that the so-called "organic impurity" of the river supply of London is appreciably below that of the Corporation of Birmingham's supply, and also of the highly reputed Loch Katrine water supplied by the Corporation of Glasgow. It is not for us to furnish an explanation of these omissions from an official and presumed impartial report.

We are, Sir,

Your obedient Servants,

WILLIAM CROOKES,

WILLIAM ODLING,

C. MEYMOTT TIDY.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.
Chief Chemist to the U.S. Geological Survey, Washington.

FLUORINE.

THE atomic weight of fluorine has been determined only by one general method, namely, by the conversion of fluorides into sulphates. Excluding the early results of Davy,† we have only to consider the experiments of Berzelius, Louyet, Dumas, and De Luca, with reference to the fluorides of calcium, sodium, potassium, barium and lead.

The ratio between calcium fluoride and sulphate has been determined by the four investigators above named, and by one general process. The fluoride is treated with strong sulphuric acid, the resulting sulphate is ignited, and the product weighed. In order to ensure complete transformation special precautions are necessary; such, for instance, as repeated treatment with sulphuric acid, and so on. For details like these the original papers must be consulted.

The first experiments in chronological order are those of Berzelius,* who operated upon an artificial calcium fluoride. He found, in three experiments, for one part of fluoride the following of sulphate:—

1.749
1.750
1.751

Mean 1.750 ± 0.0004

Louyet's researches† were much more elaborate than the foregoing. He began with a remarkably concordant series of results upon fluor-spar, in which 1 grm. of the fluoride yielded from 1.734 to 1.737 of sulphate. At first he regarded these as accurate, but he soon found that particles of spar had been coated with sulphate, and had therefore escaped action. In the following series this source of error was guarded against.

Starting with fluor-spar, Louyet found of sulphate as follows:—

1.742
1.744
1.745
1.744
1.7435
1.7435

Mean 1.7437 ± 0.0003

A second series, upon artificial fluoride, gave:—

1.743
1.741
1.741

Mean 1.7417 ± 0.0004

Dumas‡ published but one result for calcium fluoride. 0.495 grm. gave 0.864 grm. sulphate, the ratio being 1 : 1.7455.

De Luca|| worked with a very pure fluor-spar, and published the following results. The ratio between CaSO₄ and 1 grm. of CaF₂ is given in the third column:—

0.9305 grm. CaF ₂	gave 1.630 grms. CaSO ₄ .	1.7518
0.836	"	1.7459
0.502	"	0.8755
0.3985	"	0.6945
		1.7452
		1.7440
		1.7428

If we include Dumas' single result with these, we get a mean of 1.7459 ± 0.0011.

Upon combining all these series we get as follows:—

Berzelius.. .. .	1.7500 ± 0.0004
Louyet 1st series	1.7437 0.0003
" 2nd "	1.7417 0.0004
De Luca and Dumas ..	1.7459 0.0011

General mean 1.74493 ± 0.0002

For the ratio between the two sodium salts we have experiments by Dumas and by Louyet.§ According to Louyet 1 grm. of NaF gives of Na₂SO₄:—

1.686
1.683
1.685

Mean 1.6847 ± 0.0006

The weighings published by Dumas are as follows:—

0.777 grm. NaF	gave 1.312 grms. Na ₂ SO ₄ .	1.689
1.737	"	2.930
		1.687

Mean 1.688 ± 0.0007

The general mean of both series is 1.6863 ± 0.0004

* Smithsonian Miscellaneous Collections. "The Constants of Nature."

† Phil. Trans., 1814, 64.

* Pogg. Annal., 8, 1. 1826.

† Ann. Chim. Phys., (3), 25, 300. 1849.

‡ Ann. Chem. Pharm., 113, 28. 1860.

§ Comptes Rendus, 51, 299. 1860.

§ See the papers already quoted.

Dumas also gives experiments upon potassium fluoride. The quantity of sulphate formed from 1 grm. of fluoride is given in the last column :—

1.483	grms. KF	give	2.225	grms. K ₂ SO ₄	1.5002
1.309	"	"	1.961	"	1.4981

Mean 1.4991 \pm 0.0007

The ratios for the fluorides of lead and of barium are due entirely to Louyet. 1 grm. BaF₂ gave of BaSO₄ :—

1.332
1.331
1.330

Mean 1.331 \pm 0.0004

With the lead fluoride a new method of treatment was adopted. The salt was fused, powdered, dissolved in nitric acid, and precipitated by dilute sulphuric acid. The evaporation of the fluid and the ignition of the sulphate was then effected without transfer. 5 grms. of fluoride were taken in each operation, yielding of sulphate :—

6.179
6.178
6.178

Mean 6.1783 \pm 0.0002

We now have five ratios to calculate from, as follows :—

(1.)	CaF ₂ : CaSO ₄ :: 1.0 : 1.74493	\pm 0.0002
(2.)	NaF : Na ₂ SO ₄ :: 1.0 : 1.6863	0.0004
(3.)	KF : K ₂ SO ₄ :: 1.0 : 1.4991	0.0007
(4.)	BaF ₂ : BaSO ₄ :: 1.0 : 1.3310	0.0004
(5.)	PbF ₂ : PbSO ₄ :: 5.0 : 6.1783	0.0002

From these we get five values for F :—

From (1)	.. .. .	F = 18.929	\pm 0.006
From (2)	.. .. .	" 19.050	0.014
From (3)	.. .. .	" 18.975	0.032
From (4)	.. .. .	" 18.993	0.033
From (5)	.. .. .	" 19.092	0.016

General mean.. .. , 18.984 0.0065

If O = 16, this becomes 19.027.

Before leaving the subject of fluorine we must notice two possible sources of error beyond the always to be considered one of impurities in the materials employed. First, an incomplete conversion of a fluoride into a sulphate would lead to results tending to raise the atomic weight of fluorine. On the other hand, the value for fluorine which has most weight is that derived from calcium fluoride. But it was shown under calcium that the atomic weight determined for that metal was probably a trifle too high. This error introduced into our fluorine calculations tends to lower our final results. These two errors, then, if they really exist, will, in part at least, compensate each other.

DETECTION OF HYDROCYANIC ACID IN CHEMICO-LEGAL INVESTIGATIONS.

By H. BECKURTS.

HYDROCYANIC acid and the poisonous metallic cyanides are generally demonstrated in toxicological cases by acidifying the substance in question with tartaric acid, distilling, and showing the presence of hydrocyanic acid in the distillate by well-known processes. Otto, however, has proved the inaccuracy of the assumption that a mass containing potassium ferrocyanide or other non-poisonous double cyanides, and slightly acidulated, does not give off hydrogen cyanide. His experiments even prove that neutral solutions of potassium ferrocyanide, if

a current of air is passed through them, give off small quantities of hydrogen cyanide, even at common temperatures.

The following methods, which are well known, though generally neglected, are therefore to be employed :—

1. *Jacquemen's Process for detecting Hydrocyanic Acid or Potassium Cyanide in Presence of Non-Poisonous Double Cyanides.*—The mass in question is mixed with a concentrated solution of sodium bicarbonate, and distilled over the naked flame or in an oil-bath. To prevent spirting, the neck of the retort is turned slightly upwards, and connected with the refrigerator by means of an elbowed tube. The distillate is then examined for hydrogen cyanide in the ordinary manner. If the well-known reactions occur it is certain to have been present in the free state, or in the form of potassium cyanide, or similar poisonous cyanides. This method is extremely sensitive, and surpasses all others in accuracy and simplicity. It is not available for mercury cyanide, which is not decomposed by carbonic acid, even in a neutral solution.

2. *Barfoed's Process for detecting Hydrocyanic Acid and Poisonous Cyanides in Presence of Potassium Ferrocyanide.*—This method depends on the fact that ether withdraws hydrocyanic acid, but not hydroferrocyanic acid, from a watery solution. The mass in question is acidulated with sulphuric acid or tartaric acid, and shaken up with an equal volume of ether. The ether is drawn off with a pipette, and the operation is repeated with a fresh quantity of ether. The united ethereal extracts, which contain both the free hydrocyanic, and that liberated from the poisonous cyanides, but not hydroferrocyanic acid, is then shaken up with dilute soda-lye, and this solution is tested for hydrogen cyanide in the usual manner. This method is applicable in presence of mercury cyanide.—*Chemiker Zeitung* and *Archiv. der Pharmacie*.

ON THE CONDUCT OF MOIST PHOSPHORUS AND AIR TOWARDS CARBON MONOXIDE.

By IRA REMSEN and E. H. KEISER.

RECENT experiments have drawn attention anew to the question concerning the existence of an active form of oxygen distinct from ozone, and capable of effecting changes which ozone cannot effect. Hoppe-Seyler* and Baumann† hold that the oxidising action of palladium-hydrogen is due in the first instance to the splitting up of the molecule of ordinary oxygen by the active hydrogen, resulting in a momentary liberation of atoms of oxygen which exhibit very active properties. Traube,‡ on the other hand, holds that this action is due to the formation of hydrogen dioxide, and that the oxidising effects noticed are only those of the dioxide. At first, however, this explanation did not appear probable, for Baumann had shown that palladium-hydrogen in the presence of oxygen has the power of oxidising carbon monoxide, and one of us§ had previously shown that hydrogen dioxide has not this power. Traube afterwards conceded this point, but then showed that, while hydrogen dioxide itself has not the power of oxidising carbon monoxide, it has this power in the presence of palladium. We have repeated the experiment of Traube, and can confirm his statement.¶ From the evidence thus far submitted, Traube's explanation of

* Hoppe-Seyler, *Zeitschrift für Physiologische Chemie*, 1, 396; 2, 22, 25.

† Baumann, *Ibid.*, 5, 244.

‡ Traube, *Berichte der deutschen chemischen Gesellschaft*, 15, 659; 2421; 2434; 2854.

§ Remsen, *Amer. Chem. Journ.*, 4, 50.

¶ We notice that if a small quantity of free hydrochloric or sulphuric acid is present in the hydrogen dioxide, some of the palladium is dissolved. Similar observations have been made by Fairly (*Berichte der deutschen chemischen Gesellschaft*, 8, 1600; 9, 948), though the statements which we have seen concerning this phenomenon are very meagre.

the oxidising action of palladium-hydrogen certainly appears to be more probable than that of Hoppe-Seyler.

There is, however, one experiment recorded which indirectly lends some support to Hoppe-Seyler's explanation. We refer to the experiment first performed by Leeds,* and subsequently by Baumann,† which consisted in bringing air and carbon monoxide together in the presence of moist phosphorus. Under these circumstances, according to both authors, oxidation of the monoxide is effected. Accepting the conclusion, the simplest interpretation of the fact is this: The phosphorus acts upon the oxygen, splitting the molecules, uniting with some of the free atoms and momentarily setting others free. The free atoms then unite with oxygen molecules to form ozone, and with carbon monoxide to form the dioxide. This view is similar to that first put forth by Hoppe-Seyler to account for the oxidising action of palladium-hydrogen as above related. If, then, the result reached by Leeds and by Baumann is correct, we have some evidence, though it is not conclusive, of the existence under some conditions of a form of oxygen more active than ozone. We say it is not conclusive, for, as hydrogen dioxide is formed under these circumstances, we may assume that the action is due to combined influence of the dioxide and phosphorus.

The importance of the subject has led us to repeat the experiments of Leeds and of Baumann, and we have been led to a conclusion directly opposed to that recorded by these authors. As they apparently worked with great care and both agree, it will be necessary for us to describe our work in detail in order that any who may wish to convince themselves may avoid sources of error which have been overlooked in the earlier experiments.

We tried first the effect of passing air alone, freed from carbon dioxide, over moist phosphorus. After its exit from the vessel containing the phosphorus it was filtered through a layer of previously ignited asbestos contained in a tube between two and three feet long, and then into a vessel containing clear baryta water. A precipitate was formed at once, and increased in quantity the longer the current continued. It was tested for phosphoric acid and for phosphorus compounds in general, but not a trace of these could be detected. The passage of air through the apparatus was continued for some days for the purpose of collecting enough of the precipitate for examination and analysis. It proved to be nothing but barium carbonate.

The carbon dioxide must have come from one of two sources, either from some carbonaceous material contained in our phosphorus, or as the result of the action of ozone on the cork stoppers used to make connections. The exposure of rubber had been avoided almost entirely, but still there was some slight opportunity for contact of the ozone with the rubber in consequence of diffusion. As, however, we had here taken the same precautions as in the earlier experiments on carbon monoxide and ozone; as, further, Baumann‡ appears to have experienced no difficulty from the use of rubber joints, it seemed not improbable that the trouble in our experiment was in the chemical condition of the phosphorus. We hence procured specimens of phosphorus from as many different sources as possible, and with each of these repeated the above described experiment, using the same form of apparatus. In every case the precipitate of barium carbonate was obtained, and, as far as could be estimated, in about the same quantity. Attempts were then made to purify the phosphorus. One specimen was placed in hot water under the receiver of an air-pump, and the air exhausted for the purpose of getting rid of any gases which might be contained in the phosphorus. Other specimens were distilled in an atmosphere of pure hydrogen and the vapour condensed in cold water.¶ No matter what pro-

cess of purification was adopted, the phosphorus acted in the same way after the purification as before.

Attention was now directed specially to the corks and rubber connections. An apparatus was finally constructed in which these were entirely excluded, or, at least, so protected that the ozone could not possibly reach them. Although a number of different forms of apparatus were tried, we need only describe that which we finally decided upon as the best. This consisted of a flask of from three to four litres capacity, provided with a doubly perforated cork stopper. Through this there passed one glass tube reaching to the bottom of the flask, and another reaching only half way. Outside the flask the shorter tube was connected with the apparatus intended to remove the carbon dioxide from the air, and the longer tube was bent twice at right angles, and then passed through the stopper of a U-tube about eight inches high. Between this U-tube and a second like it, connection was made by means of a doubly bent glass tube. In the flask there were placed usually two or three sticks of phosphorus each three or four inches long, and enough pure water to somewhat more than fill the neck when the flask was inverted. The U-tubes were filled with ignited asbestos, and there was then added some mercury so that when the tubes were inverted, in which position the entire apparatus was placed when in use, the metal covered the corks with a layer from three-quarters of an inch to an inch in thickness. The connecting tubes passed, of course, in each case through the layer of mercury. The vessel containing the clear baryta water was also connected with the last U-tube by means of a mercury joint similar to those above described. The baryta water was protected from the action of the air by placing before it a small U-tube containing potassium hydroxide, and this last tube was connected with an aspirator. Before connecting the bulbs containing the baryta water, air freed from carbon dioxide was drawn slowly* through the apparatus. On now connecting with the baryta-water bulbs no precipitate was formed. Even on allowing the air to remain in contact with the moist phosphorus for periods varying from one to twelve hours, no carbon dioxide could be detected. This experiment was tried over and over again at different temperatures, but always with the same result.

About one-third of the air in the ozone flask was now replaced by carbon monoxide from which all dioxide had been scrupulously removed. The mixture was allowed to stand for some hours and then drawn through the baryta-water bulbs, when no precipitate was formed. This experiment was repeated a number of times with the same result. In some cases the air and carbon monoxide were drawn together slowly for a long time over the moist phosphorus, but this made no difference in the result. So frequently was the experiment performed, so great were the precautions against error, and so undeniably negative were the results, that, in spite of the explicit statements of Leeds and of Baumann, we do not hesitate to say that carbon monoxide is not oxidised when exposed to the action of air and moist phosphorus. It follows, of course, from this that the action of air and moist phosphorus on carbon monoxide furnishes no evidence in favour of the view that there is an active condition of oxygen distinct from ozone.

Leed's error is easily explained. In the first place he took no special precautions to protect the corks from the action of the ozone, and in the second place he passed the gases through a filter of moist cotton for the purpose of removing "oxides of phosphorus." Now cotton, as it is usually met with, yields carbon dioxide when subjected to the influence of ozone, so that the carbon dioxide noticed by Leeds was probably the result of the action of ozone on the cotton or the oily substances which always adhere to it. To test the probability of this explanation, we introduced a short plug of cotton into one of the tubes of our

* *Journ. Amer. Soc.*, 1, 232.

† *Zeitschrift für physiologische Chemie*, 5, 250.

‡ *Loc. cit.*

¶ In this way a new modification of phosphorus, "white phosphorus," was discovered. See next paper.

* This operation requires care and constant attention. The phosphorus not unfrequently takes fire. In one case in our experience it took fire after having stood quietly and unmolested for several hours.

apparatus. It having been shown previously that the air drawn through this apparatus contained no carbon dioxide, it was now found that the presence of the cotton alone soon caused the appearance of a precipitate in the baryta water. This experiment, was frequently repeated.

Baumann describes his experiments thus :—“Ein langsamer Strom von kohlenstofffreier Luft wurde durch eine Flasche in welcher sich feuchter Phosphor befindet, und von da in eine zweite Flasche übergeleitet, in welcher die ozonisirte Luft einem etwas langsameren Strom eines kohlenstofffreien Gemenges von 3 Volum Sauerstoff und 1 Volum Kohlenoxyd begegnet; aus dieser Flasche treten die Gase durch klares Barytwasser. Das Barytwasser blieb, nachdem aus dem Apparate selbst erst alle Kohlen-säure entfernt war, bei 6-stündigem Durchleiten der Gase völlig klar. Wurde dagegen die Mischung von Kohlenoxyd und Sauerstoff in die Flaschen eingeleitet, in welcher der Phosphor sich befand, und nach unserer Vorstellung aktiver Sauerstoff auftreten muss, so ist das Resultat ein ganz anderes: das vorgelegte Barytwasser wird schon nach kurzer Zeit trübe und im Laufe einer Stunde bildet sich ein reichlicher Nieperschlag von kohlen-saurem Baryt.”

Nothing is said about stoppers or rubber connections, and it is safe to assume that, in the apparatus used by Baumann, ozone came in contact at some points with organic matter. Hence the formation of carbon dioxide is easily accounted for. But to account for the negative result when no carbon monoxide was used is not so easy. It can only be said that, if the ozone formed is not concentrated, the action on organic connections is not marked. Now, if the temperature should happen to be a few degrees lower than the ordinary temperature of rooms, the formation of ozone would be retarded and there might not be formed enough to act perceptibly on the stoppers, &c. The rate of the current of gas is also of importance. The more rapid the current of air passed over the phosphorus the less ozone it contains, and indeed unless the current be quite slow the oxidising effect of the ozone on the organic connections does not reveal itself by the formation of a precipitate in the baryta water. Whatever the sources of error in Baumann's experiment may have been, we are confident that a repetition with the precautions taken by us will show him that his conclusion is wrong.—*American Chemical Journal*.

WHITE PHOSPHORUS.

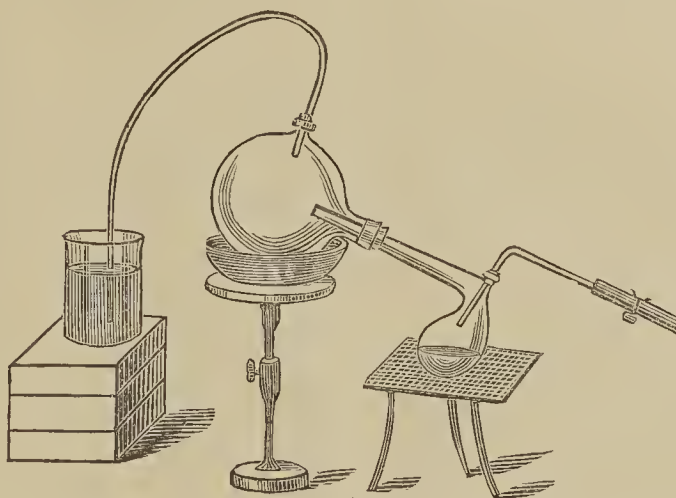
By IRA REMSEN and E. H. KEISER.

In the course of the experiments described in the preceding paper, the suspicion arose that the phosphorus with which we were working might contain some carbonaceous impurity. With the view of removing this if possible, we distilled some of the phosphorus in an atmosphere of purified hydrogen and condensed the vapour on cold water. We were much astonished to find that the substance thus obtained differed very markedly in appearance from ordinary phosphorus, and indeed we thought at first that it could not be the element, but must probably be some new oxide, formed in consequence of a slight leak in the distilling apparatus. It floated on the surface of the water in the receiver, forming a snow-white layer about a quarter of an inch in thickness. On examining it more carefully it was found that it was insoluble in water, and could be changed to ordinary phosphorus very easily. The entire quantity obtained in the first experiment happened to be brought into some warm water and was changed at once into ordinary phosphorus. We now endeavoured to prepare the substance again, but found considerable difficulty in meeting the right conditions. While we always obtained some of it, we were obliged to make a large number of experiments before the conditions of

success became clear. The experiment should be performed as described in detail below.

An apparatus like that roughly illustrated in the accompanying figure should be used.

It is essential that the neck of the retort be inclined upward and that it project well within the receiver. In the receiver there is a layer of ice-cold water from one to one and a half inches deep in the deepest part. In this, lumps of ice are brought, enough to form a fairly compact mass of ice. The receiver rests in a vessel containing cold water. The beaker into which the bent tube dips also contains cold water. Two or three sticks of ordinary phosphorus having been brought into the retort, connection is made by means of the rubber tube with a hydrogen-generating apparatus. The hydrogen is passed first through a solution of potassium permanganate and then through the apparatus as above sketched. As soon as the apparatus is completely filled with the gas the current of hydrogen is stopped by means of the pinch-cock. The distillation is now begun. As soon as the phosphorus vapour reaches the end of the neck of the retort it falls down on the ice and water and forms a white coating. Under some circumstances the material is deposited in piles reaching the height of a half an inch to an inch. The principal precaution necessary is to prevent the boiling from becoming so active that the vapour condenses to form liquid just after it leaves the retort neck. In successful operations there will be found at the end a cake of white



material floating on the surface of the water, varying in thickness according to the amount of phosphorus distilled. Usually this is quite thin. In order to remove it, it is best to allow the whole apparatus to cool down to the temperature of the air, then to disconnect the retort from the receiver, and put the receiver, with its contents, under water in a larger vessel. In this way the hydrogen can be displaced without danger, and afterwards the white phosphorus can be easily removed. If the above precaution is not taken the receiver becomes filled with a mixture of hydrogen and oxygen while the phosphorus is being taken out, and a little friction may set fire to the phosphorus, thus giving rise to an extremely unpleasant explosion. This actually happened in one of our experiments, and one of us (Keiser) still carries the marks of the explosion.

White phosphorus is light and plastic. If placed on a piece of bibulous paper so that the water is absorbed from it, it gives off dense white fumes, melts but does not take fire, and is then nothing but ordinary phosphorus. It dissolves readily in carbon bisulphide. It melts at exactly the same point as ordinary phosphorus, and at this point it is completely transformed into the latter. From these it seems clear that this curious substance bears to ordinary phosphorus much the same relation as “flowers of sulphur” to “roll brimstone.” It is in a different physical condition. It is much less susceptible to the influence of sunlight than ordinary phosphorus. We have in our possession some specimens made last October which have

undergone very little change, though they have not been specially protected from the action of the light. One specimen, which was purposely placed where the direct sunlight would be upon it for some time every day, has become slightly yellow, but is otherwise, as far as we can judge, quite unchanged. It is still plastic, and when dried acts as above described.

We have not been able to find any references in chemical literature to a substance like that which we have described. The white phosphorus referred to in the communications of Pelouze,* H. Rose,† Caignard-Latour,‡ Mulder,|| Marchand,§ and Baudrimont,¶ is the coating found on sticks of ordinary phosphorus which have been preserved under water. Böttger** also speaks of a variety of white phosphorus prepared by dissolving ordinary yellow phosphorus in alcoholic potassium hydroxide, pouring off the liquid after the phosphorus has become perfectly clear, and then adding ice-water. The phosphorus solidifies as a snow-white brittle mass, which can be pulverised under water. From Böttger's description of his product it is evident that it must be quite different from our white phosphorus.—*American Chemical Journal*.

CORRESPONDENCE.

THE DIRECT UNION OF NITROGEN AND HYDROGEN.

To the Editor of the Chemical News.

SIR,—Having been unable to attend the meeting of Section B of the British Association last month, I have been very thankful for the opportunity afforded me of reading Mr. Brereton Baker's paper in the *CHEMICAL NEWS*, vol. xlviii., page 187.

With your permission I will make a few observations in defence of the accuracy of my work on the synthesis of ammonia.

Both Mr. Baker and myself would have been saved much trouble if my paper, which was read before the Royal Society in 1881, and to which he alludes, had been honoured by publication. I presume that Mr. Baker has not read that paper, though I believe it may be read, being "in the Archives" of the Royal Society, though unpublished; for, had he done so, he would have found his objections to my work completely answered therein.

Mr. Baker rejects my hypothesis of the existence of an active form of nitrogen upon the ground that the ammonia obtained in my experiments may have been due to the presence of oxides of nitrogen derived from the reducing action of hydrogen upon solution of nitrate of silver employed to purify that gas. This source of error was pointed out to me in March, 1881, and since then I have avoided the use of nitrate of silver as a purifying agent for hydrogen altogether. Accordingly, in my paper read before the Royal Society in November, 1881, I describe my hydrogen as purified by "solution of chromic and sulphuric acids."

But the most conclusive proof that the formation of ammonia in my experiments was perfectly independent of any impurity in the hydrogen gas which I employed is contained in the following paragraph, which I quote from my paper above mentioned.

"It is always easy to ascertain whether the ammonia formed in spongy platinum is produced by the action of nitric oxide or of active nitrogen. It is only necessary or this purpose to heat the nitrogen in a glass tube to

dull redness before mingling it with hydrogen, and allowing it to enter the spongy platinum. If the nitrogen contain nitric oxide, that gas remains unaltered by the heat, passes on, and yields ammonia in the platinum; whereas, if the nitrogen be pure, any active gas it may have contained will be destroyed by the heat" (*i.e.*, rendered inactive) "and no ammonia will be formed by synthesis, as long as the tube through which it passes remains hot."

Now this somewhat dogmatic statement was the result of numerous and careful experiments; and it is at once obvious that since nothing was done to alter the *hydrogen*, the *nitrogen* alone being heated, *before its admixture with hydrogen*, the cessation of the formation of ammonia must have been due to a modification of some constituent of the nitrogen effected by the heat; and the non-production of ammonia, so long as the nitrogen was being heated, proves that *the hydrogen contained no gas capable of yielding ammonia in heated spongy platinum*.

In some recent experiments, the results of which I hope to publish *in extenso* before the close of this year, I have considerably enlarged my knowledge of the products of the decomposition of solutions of ammonium nitrite by heat. The hydrogen in these experiments was purified by solution of mercuric chloride, followed by one of caustic potash, but the results obtained have only tended to confirm my active-nitrogen hypothesis, and to convince me that nitric oxide has nothing to do with the phenomena observed.

Perhaps, Sir, as I am alluding to my paper read before the Royal Society in 1881, you will allow me to ask if any of your readers can inform me whether any chemist had observed the complete synthesis of ammonia from a mixture of nitrogen and hydrogen gases previous to that date.

I described in that paper how a mixture of pure nitrogen and hydrogen confined over strong sulphuric acid, or over mercury in presence of charcoal, if mixed in the proportions to yield ammonia, are completely, though slowly, converted into that gas by a continued series of electric sparks, the ammonia being converted into ammoniac sulphate in the first instance, and being absorbed by the charcoal in the second.

I have been told by more than one chemist that this is not my discovery; but, I ask, to whom is it due? At the Royal Society I was told that M. Henri Ste.-Claire Deville had forestalled me in this matter. But, though I have carefully studied his paper on the subject (which is very brief, *vide Comptes Rendus*, 1865, lx., pp. 324 and 325), I can only find in it a demonstration that the dissociation of ammonia by the electric spark is never perfect, and a description of the *synthesis of sal-ammoniac* by the continued action of the spark upon $N + H_3 + HCl$. My synthesis was conducted in the absence of any third gas, even in the absence of the *vapour of water*.

Mr. Donkin's partial synthesis of ammonia was effected by means of the *effluve* in an induction-tube. His results are confirmed and commented on in my unpublished paper before alluded to.—I am, &c.

G. STILLINGFLEET JOHNSON.

King's College, London,
October 22, 1883.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvi., No. 13, September 24, 1883.

Peptone of Gelatin.—M. Tatarinoff.—Gelatin, during its conversion into peptone, is not profoundly modified. It merely takes up the elements of water, as is done under similar circumstances by the albumenoids.

* *Annales de Chimie et de Physique*, 50, 83.

† *Poggendorff's Annalen*, 27, 563.

‡ *L'Institut*, 1834, No. 34.

|| *Journ. Pharmacie*, 23, 20.

§ *Journ. für Praktische Chemie*, 20, 506.

¶ *Comptes Rendus*, 61, 857.

** *Journ. für Chemie und Physik*, 67, 141, and 68, 141.

Note on the Solar Spectra. Refraction Apparatus of Rock Salt.—P. Dessain.—The author gives his results in the form of tables.

Induction due to the Variation of Intensity of the Electric Current in a Plane Circuit and in a Cylindrical Solenoid: Two Laws Analogous to those of Biot and Savart.—M. Quet.—A purely mathematical paper.

Distribution of Potential in Liquid Masses of Determinate Form.—A. Chervet.—A mathematical memoir, not admitting of useful abstraction.

No. 14, October 1, 1883.

Separation of Gallium.—Lecoq de Boisbaudran.—See p. 197.

Presence of Arsenic in Certain Wines in the Absence of Foreign Colouring-Matter.—A. Barthélemy.—The author has traced arsenic in such cases to the use of common sulphuric acid, made from pyrites, in purifying casks which had acquired a bad flavour.

Determination of Chloroform in the Blood of an Anæsthetised Animal.—MM. Gréhaut and Quinquand.—The authors distil the blood in a vacuum, and determine the chloroform by its indirect reducing action upon cupro-potassic liquid at 100°.

Bulletin de la Société Chimique de Paris.

Nos. 4 and 5, September 5, 1883.

Two Isomeric Benzyl-naphthalines.—MM. Camille Vincent and Leon Roux have obtained these two isomeric hydrocarbons by the general method with aluminium chloride devised by MM. Friedel and Crafts. The α -benzyl-naphthaline takes the form of brilliant, colourless orthorhombic laminæ. It dissolves in 60 parts of ordinary alcohol at 15°; it melts at 59°; its spec. grav. at 0° is 1.165. The β -compound forms klinorhombic prisms, which dissolves in 44 parts of alcohol at 15° and melt at 55°—55.5°. The sp. gr. at 0° is 1.176.

"Disinfection" of Alcohols of Bad Flavour by Electrolysis.—M. Laurent Naudin. A somewhat warm reply to a criticism in the *Chemiker Zeitung*.

New Copper Oxide Battery.—MM. F. de Lalande and G. Chaperon.—This paper requires the three accompanying illustrations.

Formation-Heat of the Alcoholates.—M. de Forcrand.—The author gives his results in the form of a table.

Russian Chemical Society (Meeting of February, 3/15, 1883).—M. Menschoutkine communicated his researches on the reciprocal displacement of the bases in the solutions of their neutral salts.

M. Kanounikoff sent in a note on the specific refractive energy of organic substances in solution.

M. Dieff contributed researches on an accessory product, distilling about 165° and 185°, obtained in the preparation of allyl-dimethyl-carbinol.

MM. Nikolsky and Saytzeff have conducted researches on the hydrocarbon $C_{12}H_{20}$ obtained on setting out from allyl-dimethyl-carbinol.

M. Reformatsky has investigated the hydrocarbide obtained by the action of sulphuric acid upon allyl-dipropyl-carbinol.

M. Chechoutkoff, on causing chlorine to act upon an excess of isobutylene, observes an escape of hydrochloric acid and the formation of isocrotyl chloride.

M. Kurbatoff, on causing chlorine to act upon the fraction 135°—140° of the Caucasian petroleum, has obtained a crystalline compound, $C_6H_5Cl_3$, melting at 268°.

M. Kirpichnikoff described an apparatus for obtaining a uniform flow of any liquid whatever, and a new process for extracting sulphur from its ores.

Dr. Stefanowicz has analysed the waters found in the holds of Russian ships.

M. Alekine has examined di-isooctyl prepared by the action of sodium upon a solution of capryl bromide in xylene.

M. Sokoloff described modifications introduced into his apparatus for gas analysis.

M. Potilitzine sent in analyses of water from a mud volcano in the Government of Tiflis, containing organic substances, probably acids of the fatty series.

M. W. Pavloff described a new process for the formation of the tetric acid of Demarcay.

Meeting, March 3/15.—M. Przybter described the formation of a potassium salt of glycolic acid, and the reduction of this acid to acetic acid by hydrocyanic acid.

M. Alexeef communicated the sequel of his researches on solutions.

M. Zaboudsky treated on the determination of carbon in cast-iron and steel.

M. Willm read a paper on the magnetic properties of the ores of platinum.

M. Prohoroff presented a new eudiometric apparatus for determining the oxygen of the air when in proportions between 19.5 and 20 per cent. Precise results may be obtained with this apparatus, without the use of optical instruments, the experimental error not exceeding +0.02 per cent.

M. Mendelejeff explained his researches on the petroleum of Baku. It contains saturated hydrocarbons, C_5H_{12} and C_6H_{14} , identical with the petroleum hydrocarbons of America. He has employed a new method of fractionated distillation, which is not described.

Meeting, April 7/19.—The Commission for examining the lamps for burning heavy petroleum oils, sent in in competition for the Ragsine prize, awarded the palm to the lamp of M. Kumberg.

M. Mendelejeff mentioned that the purified mixture of all the fractions of petroleum burns very well in the above-mentioned lamp, leaving no residue.

M. Poutokine sent in a paper on the allyl-dimethyl-carbinol already studied by M. Dieff.

M. Lwoff expounded his ideas on the structure of the alcohol obtained by Dieff.

M. Rassinky has undertaken researches on the fractions of petroleum distilling above 135°.

M. de Lermontoff and MM. Jakowkine, Konowaloff, and Staroboudsky are studying the fractions boiling between 115° and 150°.

M. Markownikoff presented a note on the formation of tertiary alcohols by the process of M. Butleroff.

M. Radoulowicz has effected an improvement in gas analysis.

M. Beketoff has carried on researches on the formation and properties of sodium protoxide.

M. Mestchersky has studied the decomposition of orthose under the influence of heat.

MM. Tikomiroff and Lidoff have studied the reducing action of the voltaic arc, and the transformation of iron borate into iron boride.

M. Wladowsky has discovered the presence of anthracene among the crystals deposited from the heavy oils of petroleum tar.

According to MM. Gorboff and Kessler, there are formed in the action of sodium isobutylate upon iodoform, methylene iodide and dimethacrylic acid, besides saturated fatty acids.

M. Pavloff gave a communication upon tetric acid.

M. Konowaloff described his recent investigations on the formation of pyrosulphuryl chloride, which when pure boils at 153°. He also read a paper on the solubility of secondary butylic alcohol in water.

M. Alexejeff made a communication on the specific heats of solutions and mixtures of liquids.

In the 4th Part of Vol. xv., of the *Journal of the Russian Chemical Society*, M. Alexejeff states that up to 100° the solubility of aniline in water varies very little. Above 150° it increases very quickly, and at 164.5° it mixes with water in all proportions.

M. Potilitzine gave a paper on the waters accompanying petroleum, and which are ejected by the mud volcanoes.

M. Fistchenko announces that the products of hydrochloric, hydrobromic, and hydriodic acid upon oxymethylene are formic acid and methyl chloride, bromide, and iodide.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin.
Vol. 16, No. 3.

Potassium Sesqui-carbonate.—C. Rammelsberg.—The author shows that this disputed salt exists in a solid, crystalline form, though the conditions under which it is produced have not been determined.

Condensation-product of Phenanthren-quinone and Acetacetic Ether.—F. J. Japp and F. W. Streatfeild.—The compound obtained, $C_{20}H_{16}O_4$, receives the name phenanthroxylene-acetacetic ether. The authors further examine the behaviour of this body with hydriodic acid, which leads to the formation of β -phenanthroxylene-crotonic ether, and the reactions of this last compound with caustic alkalies.

Acetone-addition under the Influence of Caustic Alkalies.—F. R. Japp.—The author mentions that he has been for some time engaged in the study of reactions in which di-ketones, under the influence of ammonia or potassa, take up 1 or 2 mols. acetone. The first compound of the kind obtained has been provisionally named phenanthren-quinimid-acetone.

Condensations of Compounds which contain the Dicarboxyl Group with Aldehyds and Ammonia.—F. R. Japp.—A discussion concerning the constitution of para-oxal-methylene.

α -Nanthol-aniline, α -Nanthol-xylidine, and α -Nanthol-naphthylamine.—A. R. Leeds.—The author has obtained and analysed these compounds, and remarks that all as obtained synthetically by the direct combination of a molecule of α -nanthol with a molecule of the organic base without the separation of water, have a relatively high combination-heat.

Chryptidine.—A. R. Leeds.—The author has succeeded in producing chryptidine synthetically.

Insoluble Residue obtained on Distilling Castor Oil in a Vacuum.—A. R. Leeds.—An examination of a tough elastic mass obtained in preparing α -nanthol from castor oil. This compound has the composition $C_{42}H_{68}O_5$, and is capable of saponification on prolonged treatment with potassa.

Acroleinureide, with Remarks on H. Schiff's Communications on Condensed Ureides.—A. R. Leeds.—A controversial paper. The author considers that all the researches of Schiff on the ureides require repetition and confirmation.

Addition of Bromine to Acetacetic Ether.—C. Duisberg.—A reply to the papers of Lippmann (*Berichte*, xv., p. 2142) and of Conrad (*Berichte*, xv., 2133).

Action of Phthalic Anhydride upon Quinoline.—C. Traub.—A preliminary communication. The author obtains by this reaction, not quinoline phthaline, but a compound which he names quino-phthalon, insoluble in water, freely soluble in hot benzol and glacial acetic acid, fusible at 235° , and capable of sublimation, though with partial decomposition.

Ortho-beta-oxy-naphthoyl-benzoic Acid.—H. Walder.—An account of this acid, of its sodium, barium, and silver salts, its methyl and ethyl ether, its acetyl compound, and its behaviour with melting potassa.

Mutual Displacement of Bases in the Solutions of their Neutral Salts.—N. Menshutkin.—This memoir will be inserted at length.

Formation of Arsenides by Pressure.—W. Spring.—A study in detail of the reactions which ensue on submitting pulverised bodies to strong pressures. He has

experimented with arsenic and zinc, arsenic and lead, arsenic and tin, arsenic and cadmium, arsenic and copper, and arsenic and silver.

Noack's Memoir on a New Method of obtaining Carbon Monoxide.—H. Jahn.—The writer shows that Noack has been anticipated by Prof. E. Ludwig and by himself (*Kais. Akad. d. Wissenschaft.*, April, 1880).

Compounds of Hydrocyanic Acid with Hydrochloric and Hydrobromic Acids.—L. Claisen and F. Matthews.—The authors have obtained and examined hydrocyano-sesqui-hydrochlorate, $2CNH + 3HCl$, and the corresponding bromine compound, both of which are white crystalline solids, insoluble in alcohol, but soluble in water with decomposition.

Glutamine.—E. Schultze and E. Bosshard.—Glutamine, on heating with baryta water or alkalies, takes up water, and is resolved into ammonia and glutamic acid. It undergoes the same transformation if boiled with acids, and is therefore analogous in its behaviour to asparagine.

Action of Chlorine upon Sulphone Compounds and Organic Oxy-sulphides.—W. Spring and C. Winsinger.—Not adapted for abstraction.

NOTES AND QUERIES.

* * Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

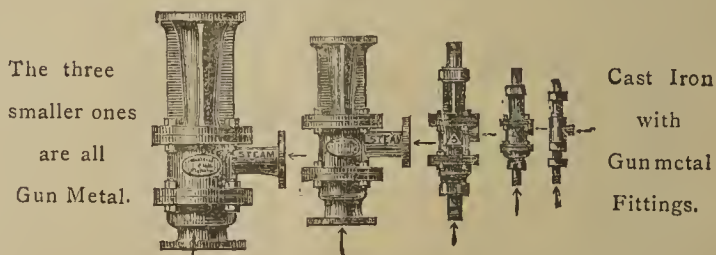
Recovery of Sulphur from Spent Oxide.—(Reply to A. S.)—Apply to Schofield, White, & Co., 4, New London Street, Mark Lane, E.C., large buyers of spent oxide. The sulphur is readily dissolved by bisulphide of carbon, which can be recovered by evaporation in a closed retort, &c. It might be better to apply heat and obtain sulphur by sublimation direct without the solvent. If you fail to obtain desired information repeat the question.—G. A. K.

MEETINGS FOR THE WEEK.

THURSDAY, Nov. 1.—Chemical, 8. "On the Production of Hydroxylamine from Nitric Acid," by Dr. Divers. "On some Compounds of Phenols with Amido-Bases," by Gibson Dyson. "Chemistry of Lacquer (Urushi)," by H. Yoshida.

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THE CHEMICAL NEWS.

VOL. XLVIII. No. 1249.

CONSTANT PRODUCTION OF OXYGEN GAS BY MEANS OF *PROTOCOCCUS PLUVIALIS* AND THE ACTION OF THE SUN'S RAYS.

By Dr. T. L. PHIPSON, F.C.S., &c.

FROM March to August of the present year I have devoted much time to what is termed the *respiration of plants*, and have made a considerable number of experiments with phanerogams and cryptogams. The results of these researches will be given later, for they are not yet completed. In the meantime I wish to make known a very efficient manner of obtaining oxygen gas in considerable quantities by means of the microscopic plants *Protococcus pluvialis* and *P. palustris*—two closely allied unicellular algæ, which abound in little pools of rain-water and in pump-water exposed to the air.

In almost all text-books it is stated that plants have the power of decomposing carbonic acid and liberating its oxygen, whilst the carbon is "fixed in the vegetable tissue." This statement is quite incorrect: plants have no power of decomposing carbonic acid into oxygen and carbon, nor into oxygen and carbonic oxide. Even in the laboratory the decomposition of carbonic acid is an arduous undertaking requiring violent methods, such as that which I showed formerly in my paper on magnesium by the action of that metal on carbonate of soda at a great heat. Plants absorb carbonic acid from water or air when it is present in the proper proportions (in large quantities it appears to poison them), and oxygen is evolved from their tissues as a consequence of this absorption; but *the carbonic acid is not decomposed*. Water or peroxide of hydrogen is as essential as carbonic acid to the production of oxygen, and the phenomenon which occurs may be briefly stated thus: there are two modes (a) and (b):—

(a) $\text{CO}_2 + \text{HO} = \text{CHO} + \text{O}_2$ —Inferior plants.

(b) $\text{CO}_2 + \text{HO} = \text{CHO}_2 + \text{O}$ —Higher plants.

The form (a) indicates the formation of *sugar, starch, cellulose, gum, &c.*; the form (b) that of *acids, glucosides, &c.*

The reaction (a) predominates in inferior plants without excluding (b); that is why they give more oxygen, in general, than higher plants, added to which they live indefinitely in water, in the condition to be referred to, which is difficult to obtain even with aquatic plants of a higher nature.

On a fine summer morning, when the sun has been above the horizon for 4 or 5 hours, we see the *Zygnema* and *Conferva* borne up to the surface of pools of stagnant water by thousands of minute gas-bubbles. When this gas is collected and analysed it is found to be very pure oxygen. The *Protococcus pluvialis* and *P. palustris*, which are among the simplest of unicellular algæ, I have found to be very remarkable in this respect.

Expose a saucer to the rain for a few months, or leave it, full of pump-water, exposed to air and light for some weeks, and it soon contains *Protococcus pluvialis* in abundance. Place some small dead branches of poplar in the saucer, and both *P. pluvialis* and *P. palustris* develop rapidly upon them in the course of a week or two.

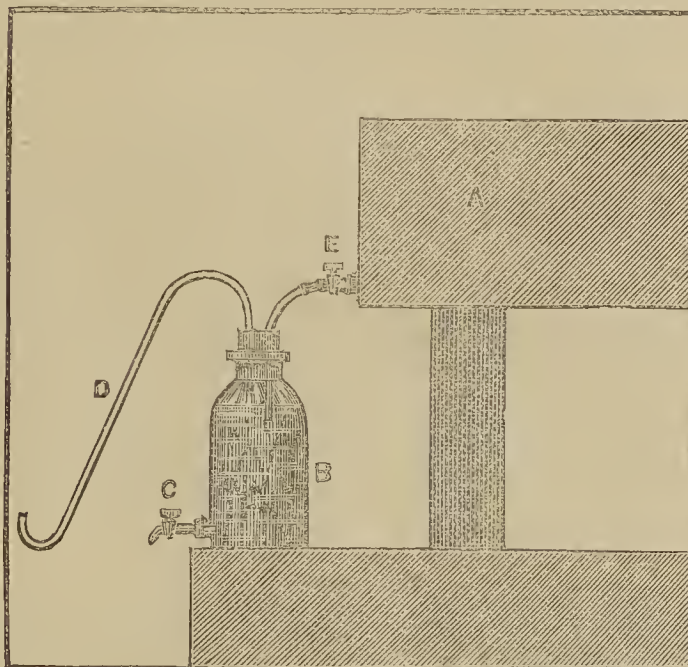
These small branches can then be placed in a flask full of pump water and the evolution of oxygen observed under the influence of the solar rays.

When higher plants, such as *Achillea millefolium*, are experimented on in this way, the gas accumulates at the extremities of the leaves, sometimes in bubbles of considerable size, which finally escape and come to the surface in

quantities varying from the size of a pin's head to that of a pea or a bean. But with the *Protococcus pluvialis* and *P. palustris* the escape of gas is constant, and each bubble is of the minutest size. No sooner do the sun's rays strike the flask than a series of these microscopic bubbles—veritable atoms of oxygen—commence rising in all directions, and from their great number create quite a froth upon the surface. The flask being turned upside down for the purpose of collecting and ascertaining the composition of the gas, this state of things will continue for about three days; after that time all the carbonic acid contained in the water is absorbed, and the escape of oxygen gas ceases. (A minute quantity of caustic soda will cause it to cease on the first day, by depriving the plant of carbonic acid.)

When the water is renewed the same phenomenon recommences, so that by keeping up a constant supply of pump-water the production of oxygen may be kept up for months, and probably years together.

This is effected by means of the simple apparatus now to be described:—



The water used is pump-water (water that has been boiled or distilled will not answer, nor will the phenomenon occur if the slightest quantity of alkali of any kind be present in the water). The tank A is of slate or earthenware; it is full of pump-water on which the sun's rays cannot act on account of the opacity of the sides; it is kept filled and covered. B is a large wide-mouthed and tubulated glass flask, in which are placed the dead branches of poplar covered with *Protococcus pluvialis* and *P. palustris*. (These microscopic plants are almost invisible, save that here and there on the dark epidermis of the branches little patches of green matter are observable.) The flask B is exposed to the direct rays of the sun. The flow of water from the tank A is regulated by the tap E, and that from the flask by the tap C, so that the contents of the latter are completely renewed in the course of three days; or the water in B may be completely drawn off every third or fourth day.

In these conditions any quantity of oxygen may be produced in a short space of time: the quantity yielded in any given interval of time depends solely upon the size of the apparatus.

The oxygen can be received in a gasometer by means of the tube D, or into a graduated tube. In the latter case the apparatus appears capable of being transformed into an excellent *actinometer*: the number of divisions (cubic centimetres of gas) taken on the graduated tube every day from 8 to 9, or 12 to 1, giving the exact measure of the actinism for the day in question. But the present form of the apparatus is not suitable for this purpose; for, sup-

posing there were five hundred thousand distinct individuals of *P. palustris* present in the flask on any given day, this number might be six hundred thousand or more on the following day, and so the results would not be comparable.

The small dead poplar branches form a very convenient medium for transferring the *Protococcus* from one flask to another (for instance, when the flask first used becomes dull or opaque and requires cleaning). Having been exposed to the rain for a long period of time they are invariably covered with *P. pluvialis* and *P. palustris*, though the presence of these minute plants is not easily recognised, and when placed in pump-water exposed to the light, the latter develop rapidly, and multiply enormously during the whole year.

Two analyses of the gas produced by *Protococcus pluvialis* and *P. palustris* in these experiments gave me:—

Oxygen = 98.7 and 98.0 per cent.

London, Oct. 20, 1883.

APPARATUS FOR ESTIMATING CARBON IN STEELS.

By ADDISON B. CLEMENCE.

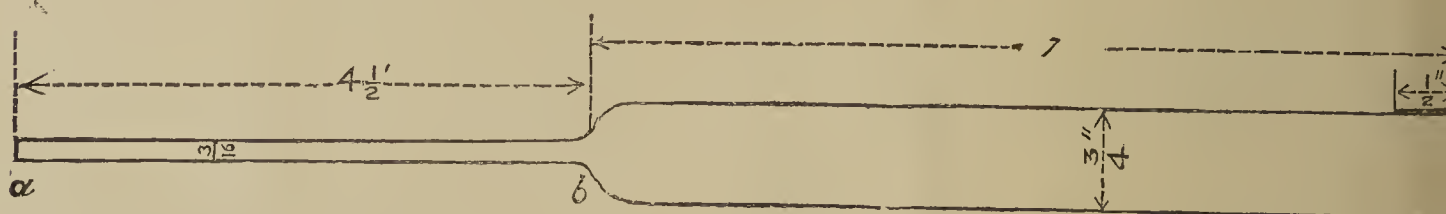
A DESCRIPTION of the apparatus in use at the works of the Washburn and Moen Manufacturing Co., of this city, will, I think, be of interest to those who desire an accurate method for the estimation of carbon in steels. The apparatus has been in use in the works for the past three months, and has given entire satisfaction.

The method of filtering the carbon on to asbestos in a glass funnel, drying, transferring to a porcelain tube, and burning in a stream of oxygen gas, is accurate if all the carbon can be separated from the sides of the funnel, which, in some cases, is almost impossible.

Again, the method of filtering on to asbestos in a platinum tube or boat-shaped apparatus, and putting all in a porcelain tube, and burning as before, has also been used, and, of course, is less liable to error.

My aim has been to do away entirely with the porcelain tube and combustion furnace, and to filter and burn in the same tube.

The sketch shows the form of apparatus I have adopted, being made of platinum.



The following is the process I use:—

Dissolve from 3 to 5 grms. of the borings in double chloride of copper and ammonium, using 36 grms. of the salt to 120 c.c. water for 3 grms. of steel. After the separated copper is completely dissolved, filter on to a plug of asbestos placed at *b*, and wash thoroughly with hot water. Any carbon that adheres to the sides of the tube may be swept down by moistened asbestos. The tube is then placed in an air-bath, and dried at a temperature of from 150° to 175° C. for about one hour. A hard rubber cork, through which is passed glass tube, is inserted at *c*, the oxygen gas passing from *c* to *a*. Around the tube at *c* is a single thickness of filter-paper, about two inches wide, kept wet by a stream of water supplied by a reservoir on a shelf above. Heat is applied at *b* for one-half hour, at the end of which time the potash bulb is ready for the balance. One Bunsen burner is sufficient for the combustion. The same precautions are taken to dry the gas before entering the platinum tube, as well as before

entering the potash bulb, as in the case with the porcelain tube method.

Six burners of a combustion furnace will consume 14 ft. of gas in one-half hour, while one Bunsen burner will consume 2 ft. in the same time.

The following table shows some results obtained by the "platinum tube" process:—

A, is a Swedish Bessemer containing 0.10 per cent of carbon.

B, an American Bessemer, with 0.18 per cent, and

C, an American Bessemer with 0.50 per cent.

All obtained by the "porcelain tube" process.

	A.	B.	C.
1.	0.09	0.18	0.49
2.	0.10	0.18	0.51
3.	0.10	0.16	0.49
4.	0.10	0.17	0.44

NOTE.—If pure closely-woven asbestos cloth can be obtained, I see no reason why, with two potash bulbs, twelve combustions may not be made in one day, for each filter with its contents may, when dried, be put in the platinum tube and burned.

Washburn and Moen Manufacturing Co.,
Worcester, Mass., U.S.A., Sept., 1883.

APPLICATION OF THE FUNDAMENTAL LAWS OF PHYSICS TO CHEMISTRY.*

By Prof. W. C. WITTMER.

THERE are in nature two distinct inert substances, and whatever is described in chemical text-books under the name of the chemical elements is always a combination of the above two substances. One of them is that which is known by physicists as luminiferous ether, and to the other I have given the provisional name of mass substance. For the present each of the two elements must be supposed as existing in the form of small spheres. As regards the ether spheres there is for the present no reason for assuming a difference in their magnitude or in their proportion of inert substance. As regards the mass spheres we must admit as many distinct formations and different quantities of the inert mass contained in the spheres as there are elements enumerated in chemical treatises. It

will doubtless appear as regards the elements of high atomic weights that they are compounds of others of lower atomic weights, but for the present nothing decisive can be said on this point.

Both elements obey the following laws:—

1. Between the homogeneous there is mutual repulsion; between the heterogeneous mutual attraction.
2. All forces decrease inversely as the square of the distance.

According to existing determinations a molecule of the ether is able to neutralise as much mass-substance as is contained in 19.8 atoms of hydrogen.

If a mass-sphere of the magnitude of a hydrogen atom is found in space filled with ether, an ether atom combines with it in such a manner that both spheres approach up to contact. If we represent the particle of ether by a small

* A Paper read before the Freiburg Meeting of German Naturalists and Physicians.

circle and the mass particle by a larger circle than an atom of hydrogen is represented by $\circ\text{O}$. Both spheres act now upon the surrounding ether each in its direction, and on that side of the mass-sphere which is turned away from the ether particle there will be that particle of ether which approaches nearest the combination, because the action of the particle of ether already taken up is here feeblest on account of the greater distance.

If the mass-atom grows, or if it is replaced by a larger one, the second particle of ether approaches more and more, and when the mass-particle m has reached five-fold the magnitude of hydrogen, a second ether-particle is taken up in addition to the first. The atom has then the form $\circ\text{O}\circ$.

When the mass-sphere is seven times as large as that of hydrogen there are consequently two particles of ether in immediate combination with the mass-sphere, and the external action of the combination is especially an ether-action of which only $\frac{7}{19.8}$ are neutralised by the mass particles.

We have thus the strongly electro-positive lithium. By the further growth of the mass-sphere the predominance of the ether-action decreases more and more, and in like manner the positive character of the elements. When m is 19 times as large as in H the minimum of the ether-action is reached, and we have the negative fluorine. If m still increases, it takes up, between 19 and 23, a third particle of ether, and hence in the next element, sodium, there is again a predominance of the ether-action, whence sodium is strongly electro-positive. The arrangement of the constituents is then—



If m still increases, the predominance of the ether-action decreases, the electro-positive character of the element is lost, and at 35.5 we reach the electro-negative chlorine. Between 35.5 and 39 a fourth particle of ether is taken up, and potassium is again strongly electro-positive. Between chromium and manganese a fifth ether-particle is taken up, and between bromine and rubidium a sixth, and so onward. From the electro-positive elements of a series there is a gradual transition to the electro-negative as the value of m rises, whilst there is an abrupt transition from the most electro-negative element of one series to the most electro-positive element of the next.

Proceeding from these principles chemical processes may be calculated as well as the physical and the astronomical, though on account of the many factors to be taken into account the calculations are tedious and complicated. In a separate treatise, "The Molecular Laws," I have deduced the laws which govern the material world, and in a series of papers which have appeared in *Schlömilch's Zeitschrift für Mathematik und Physik*, I have given the calculations for the elements hydrogen, oxygen, potassium, sodium, lithium, chlorine, and their simple compounds. It may thus be proved that the atoms of hydrogen, oxygen, and chlorine have the disposition to form molecules by uniting in pairs; that oxygen and chlorine readily unite with the alkaline metals, but not with each other, &c.—*Chemiker Zeitung* (Cæthen).

CHEMICAL EXAMINATIONS OF THE WATER OF THE BRINE-SPRINGS OF STOKE PRIOR, WORCESTERSHIRE.

By A. B. GRIFFITHS, M.A., Ph.D., F.C.S.,
Medallist in Chemistry and Botany, &c.

THESE brine-springs of Stoke Prior, near Bromsgrove, are the property of Mr. John Corbett, M.P., whose extensive works (one of the finest and largest in the kingdom) I had the pleasure of visiting several times this summer. The deposits of rock-salt in this neighbourhood, like most, if not all, the English deposits, exist in the

Lias or upper members of the New Red Sandstone formations.

The following are the results of some recent analyses by myself of this brine (which is pumped up from a depth of over 300 feet). I also give the results of the analyses of this brine by the late Mr. A. Beauchamp Northcote, F.C.S., which he published in the *Philosophical Magazine* for January, 1855 —

	Analysis by Mr. A. B. Northcote, F.C.S. (1854).	Analyses by Dr. A. B. Griffiths (1883).	
		I.	II.
	Per cent.	Per cent.	Per cent.
Soda	13.7779	13.7741	13.7752
Lime	0.1075	0.1092	0.1085
Magnesia	0.0165	0.0159	0.0173
Ferric oxide	trace	trace	trace
Chlorine	15.4697	15.4620	15.4683
Phosphoric acid	trace	trace	trace
Silicic acid	trace	trace	trace
Lithium	—	trace	trace
Bromine	trace	trace	trace
Potash	trace	trace	trace
Sulphuric acid	0.4888	0.4890	0.4892

The percentage of sodium chloride is 25.49; therefore the brine is a saturated solution of sodium chloride, and its specific gravity is 1.2049 at 24° C.

ON THE PROBABILITY OF A TRANSFORMATION OF STRYCHNINE IN THE ANIMAL ORGANISM AND ON AN OXIDATION PRODUCT OBTAINED FROM STRYCHNINE ON TREATMENT WITH POTASSIUM PERMANGANATE.

By Prof. PLUGGE.

THE question whether the alkaloids undergo any change in the organism and especially as regards strychnine, has been some times affirmed and again distinctly denied.

The number of cases in which strychnine could not be discovered in the bodies of poisoned persons, or in the urine after the ingestion of medicinal doses, is very large.

The opposite results of many chemists, who have detected strychnine in the blood, the liver, the kidneys, and the urine, prove merely that in many cases strychnine may be found in these substances. But they fail to disprove a decomposition of strychnine in the organism; they show that a portion of undecomposed alkaloid is present, but they can never prove that another portion has not been decomposed. Kerner (*Pflüger's Archiv.*, ii., 20, and iii., 30), proved that after the use of quinine, a part of this alkaloid appears unaltered in the urine, whilst another portion becomes di-hydroxyl-quinine, a compound which is also obtained by treating quinine with permanganate in certain proportions.

The possibility of an analogous result with strychnine led to the following experiments:—

Strychnine was given to different animals, and their tissues, blood, and urine were then examined for an oxidation-product bearing the same relation to strychnine as does di-hydroxyl-quinine to quinine.

The attempt was made to obtain a product similar to di-hydroxyl-quinine by treating strychnine with permanganate.

The results obtained in the first set of experiments are of such a nature as to indicate an essential decomposition of strychnine in the organism, though the investigation is not yet completed.

The second set of experiments have given decisive results. The body obtained by treatment with permanganate is amorphous, of a yellowish-brown or

light-grey colour, sparingly soluble in cold, but more freely in hot water, from which it is partially re-deposited on cooling. It is readily soluble in alcohol, sparingly in ether and chloroform, very readily in dilute aqueous alkaline solutions, whence it is incompletely re-precipitated by the addition of hydrochloric acid.

That this body has in a great degree lost the properties of an alkaloid appears from the fact that it is not precipitated by phospho-tungstic and phospho-molybdic acid, iodised potassium iodide, potassium cadmium iodide, potassium-mercury iodide, &c.

If the strychnine derivative is treated with potassium-dichromate and sulphuric acid a splendid red-violet colour appears, whilst with strychnine there is formed first a blue-violet colour, which afterwards turns to a reddish violet. The change of colour in the strychnine reaction depends on a permanent oxidation of the alkaloid.

The strychnine derivative is not bitter and not poisonous. It may be regarded as strychnic acid, being preliminarily represented by the formula $C_{11}H_{11}NO_3 \cdot H_2O$.—*Arch. Pharm. and Chemiger Zeitung Cöthen*.

POSSIBLE VARIABILITY OF THE LAW OF DEFINITE PROPORTIONS.

By Professor J. P. COOKE.

In the July number of the *American Journal of Science* (page 63), Professor Barker has given a very full summary of the views of Boutlerow on this subject, which have been recently presented to the Chemical Society of Paris by Wurtz, and emphatically endorsed in the discussion which followed by Schutzenberger. The opinion was then and there clearly expressed that the "chemical value" of a constant weight (or rather mass) of a substance might vary, and that the so-called atomic weight of an element might be simply the carrier of a certain amount of chemical energy which is variable within narrow limits; and further the question was asked whether "Prout's hypothesis may not be a true law which, like that of Mariotte, admits of a limited variation." Moreover numerous facts were cited, chiefly results of quantitative analysis, which seemed to confirm the views thus expressed. Such opinions are certainly very revolutionary, and, if they prevail, must entirely change the fundamental conceptions of chemical philosophy. Chemical combination can no longer be regarded as the juxtaposition of the definite invariable masses we call atoms, but must be considered as the "reciprocal saturation" or "interpenetration" of masses which may vary with the relative strength of their chemical energy acting at the time; and this change of the fundamental conception is inconsistent with the atomic theory and with the superstructure which modern chemistry has built upon it.

In the connection above referred to it is stated that Boutlerow had held the views then advanced for the past three years. Such views are, however, by no means new. They were not only expressed, but fully worked out, by the writer more than twenty-five years ago. They were presented to the American Academy of Arts and Sciences in 1855 and fully developed in a paper published in the *Memoirs of this Academy* (New Series, vol. v., p. 337) "On Two New Crystalline Compounds of Zinc and Antimony and on the Cause of the Variation of Composition observed in their Crystals." The same subject was also discussed in a paper published in the same Journal, "On an Apparent Perturbation of the Law of Definite Proportions observed in the Compounds of Zinc and Antimony" (Second Series), vol. xx., 1855). In these papers the opinions now under discussion were brought forward, not simply as speculations, but as a legitimate theory, which was advanced to explain the facts observed in a long and laborious investigation of the order of the variation in the composition of certain well-defined crystals, obtained by

the author from alloys of zinc and antimony of different percentage composition by the "method of fusion." Alloys were crystallised differing from one-half to five per cent, according to circumstances, from the alloy containing 95 per cent of zinc to that containing 95 per cent of antimony, and analyses were made of the crystals thus obtained. Two well-marked types of crystals, and only two, were obtained corresponding to the composition Sb_2Zn_2 and Sb_2Zn_3 ; but it was found that while crystals of the first type might be made either with an excess of zinc or an excess of antimony, the crystals of the second type would only take an excess of zinc; and the whole order of the phenomena indicated—first, the action of a force tending to unite the metals in one of two definite proportions; secondly, the effect of the excess of one or the other metal in the alloy tending to disturb this result; thirdly, the interference of the two compounds with each other in alloys of intermediate composition. The results were plotted and a curve drawn showing the order of the variation, and this curve indicates plainly—first, the strong tendency of the chemical force, and secondly the disturbing effect of the excess of either metal in the alloy. Moreover, the manner in which these two influences modified each the other's action seemed to preclude the supposition that the results could be the effect of a simple mechanical enclosure by the growing crystals. For all these details we must refer to the paper cited. We will only quote a few sentences which indicate the drift of the writer's opinions at the time.

"In the absence of any known principle of chemical science by which the remarkable variations of composition that have been demonstrated in this memoir can be explained, the conclusion is almost forced upon us that zinc and antimony are capable of uniting and producing definite crystalline forms in other proportions than those of their chemical equivalents; in other words, that the law of definite proportions is not so absolute as has been hitherto supposed."

"Accepting the view of the subject that has been offered, it will be obvious that the very large extent of the variation in the compounds of zinc and antimony is due to the very weak affinity between these elements. Were the chemical force stronger in proportion to the disturbing force, the variation would be lessened; were it weaker, the variation would be increased."

"To what extent this perturbation of the law of definite proportions prevails among chemical compounds, it must remain for future investigation to determine. There are, however, a number of facts which tend to prove that it is very general whenever chemical affinity is weak." Examples are cited in the memoir.

"If variations in composition of such magnitude are possible when the force of chemical affinity is weak, it is highly probable that some variation may occur when the force is strong; and whatever view may be taken of the cause of the variation, it will now become a matter of importance to ascertain whether many discrepancies of analysis hitherto referred to imperfections in the process may not be owing to the same cause which influences the composition of the crystals of the antimonides of zinc."

"The definite proportions I regard as a maximum toward which the chemical force strives, a maximum from which the deviations in most cases are small, although in others they may be very large; and I maintain that this view of the subject, which the memoir has aim to establish, is supported by the analogies of nature."

"I have shown in a former memoir that these numbers" (the equivalent numbers) "may be connected by a very simple numerical law, but here, as in other cases, we find merely a tendency towards the law, not an absolute agreement with it, the differences between the theoretical and the experimental equivalents being in many cases too great to be covered by errors of observation. The present memoir may throw light upon these discrepancies: for, to say the least, it is possible that the differences may originate in variations of the equivalent itself, and that the

theoretical equivalent may be the maximum towards which the chemical force tends."

In a subsequent paper entitled "Crystalline Form not necessarily an Indication of Definite Chemical Composition, or on the Possible Variation of Constitution in a Mineral Species independent of the Phenomena of Isomorphism," published in the *Philosophical Magazine* (June, 1860), during a visit to London, the writer shows that whatever explanation may be given of the variations of composition, which he had previously described, such variations must necessarily modify the composition of many crystalline mineral products. Examples are cited in which this is obviously the case, and it was proposed to designate by the word "Allomerism" "a variation in the proportions of the constituents of a crystallised compound without any change in the crystalline form."

Now when after twenty-five years the same question is revived, although without any reference to previous work on the subject, and the same opinions are expressed under conditions more likely to give them currency, it becomes interesting to enquire whether the progress of chemistry during the interval has tended to confirm or invalidate these views. So far as the writer is aware no investigation except his own already referred to, has been directed to the exact spot in question, and in none of the analytical results which have been more recently cited as possible examples of variation in the combining proportions has it had been conclusively shown that the discrepancies may not result from causes such as will be considered below.

During the last twenty-five years, however, a more extended knowledge has been acquired of that class of indefinite chemical compounds which like the alloys seem to occupy an intermediate position between definite composition and solution. Such compounds, for example, as many of the hydrates and silicates in which it is impossible to mark the limits between chemical and mechanical action. As in the case of the crystalline compounds of zinc and antimony, so in all such cases, some mechanical action—such as is manifested in what we call solvent power—seems to modify the chemical force: but in no case except the first has any attempt been made to investigate the interaction of the two. The atomic theory explains such cases of indefinite combination by distinguishing between atomic and molecular union, and it regards the complex products as resulting from an aggregation of dissimilar molecules, in each of which, however, the law of definite proportion rigorously holds. It is necessary, however, in many cases to assume the existence of very complex molecules, and the doctrine of interpenetration certainly gives a simpler conception of this class of phenomena.

On the other hand, the extension of our knowledge has either brought to light new facts or given prominence to old ones, which, by explaining anomalies, have tended to confirm the atomic theory. It has been found that crystals have a very remarkable power of enclosing foreign materials in their structure, so that at times the crystallising material forms but a small portion of the resulting mass. If a crystal may enclose material wholly foreign to its composition, why may it not enclose an excess of either of its ingredients? There can be no doubt that in such cases the amount of material thus enclosed depends to a greater or less extent on the chemical force, and there is a continuity in the composition of the products which makes it difficult to distinguish between the material controlled by the chemical force and that which is not, and gives at least the appearance that the amount so controlled may be variable.

On the assumption, however, of the existence of molecules and atoms it is a very probable hypothesis, that when we bring together in solution or in fusion substances capable of yielding definite compounds, the number of molecules of such compounds that would form at any one time must depend—certainly among other conditions—on the strength of the chemical force as well as on the pro-

portion of the several materials present. When, now, crystals form in such a menstruum we should expect that while the molecules of the definite compound would aggregate together, the crystalline structure thus formed would enclose, to a greater or less extent, molecules of one or the other of the constituents of this compound if present in excess, and the amount of such enclosure must depend on the relative proportion of the molecules in the menstruum; and this proportion, as we have seen, must have been already determined by the strength of the chemical force. Thus might arise such a regulated variation of composition as the writer's investigation indicated. The extent of the formation of molecules of definite composition in the menstruum would obviously be regulated by conditions whose action would determine no break of continuity; but the segregation of these molecules in the formation of crystals would cause at once a sudden change. Crystallisation is always a break of continuity, and although the crystalline structure may, as we have seen, enclose foreign material to a very large extent, yet, as the writer's investigation proved, there is always, even in extreme cases, a tendency to exclude such material, a tendency which is the more effectual in proportion as the crystalline molecules preponderate in the menstruum. Hence it is that by repeated crystallisation perfect purity may, in most cases at least, be secured. The hydrates of sulphuric acid furnish a good illustration of the theory we are discussing. Water and oil of vitriol may be mixed in any proportion and there is a perfect continuity between the various stages of dilution. When, however, on exposure to cold the definite hydrate $\text{H}_2\text{SO}_4 \cdot \text{H}_2\text{O}$ crystallises out, this continuity is abruptly broken, and it is reasonable to suppose that the molecules of this compound pre-existed in the liquid and only aggregated in the process of crystallisation. These crystals may be obtained between quite wide limits of dilution, and must enclose more or less of the menstruum, and, therefore vary in composition to a limited extent; but the definite hydrate can be obtained pure by repeated crystallisation.

Another class of facts bearing on the same subject has been forced upon the writer's attention during the last few years by the investigations he has undertaken on the revision of the atomic weights. In a memoir on the "Numerical Relations between the Atomic Weights," which he communicated to the American Academy of Arts and Sciences, February 28th, 1854, he remarked—as the result of a careful discussion of the determinations which had been made up to that time—that the constant errors "seem to be the great errors in all these determinations, those accidental errors which were made in the repetitions of the same process by equally careful experimenters being comparatively insignificant." The writer's subsequent experience has entirely confirmed this opinion.

Of these constant errors by far the most important are those due to impurity of material, whether in the substance analysed or in the products of the analysis. No problem of chemistry is more difficult than to prove that the materials and products involved in atomic weight determinations are perfectly pure, and represent a condition in which the elements are united in the definite proportions sought. It is of course very easy to discover such impurities as can be detected by well-known analytical processes. But how can you be sure that a given oxide, sulphide, chloride, bromide, or iodide, does not contain a similar compound of a lower or higher order? How can you be sure that either of these compounds does not contain a small amount of oxide? It is such impurities as these that are the chief source of uncertainty, and they cause variations of composition precisely similar to those discussed above. By referring to the examples cited on page 65 of this volume it will be found that they are for the most part, if not all, open to a suspicion of errors of this kind, and until these suspicions are removed the evidence which the alleged discrepancies furnish is not trustworthy. As a rule, when a substance is formed by a simple

reaction from perfectly pure materials, the purity of the product is taken for granted, and yet the writer as shown that sulphide of antimony, when precipitated by hydric sulphide from tartaric acid solutions acidified by hydrochloric acid, invariably contains more or less oxychloride of antimony, which leaves its equivalent or oxide of antimony when the sulphide is dried at 200° C. So also he found it impracticable to prepare chloride of antimony free from oxide.

It may then well be asked what proof can we have of purity in such cases as have been discussed beyond the very definiteness of composition which is in question? Before attempting to answer this question the writer would call attention to the fact that constancy of analytical results affords no certain criterion of purity. In the writer's own experience constancy of results has frequently meant nothing but constancy of impurity, and the allusion caused by coincidences so-called has been forced again and again on the writer's attention. Hence no valuable conclusion can be reached by attempting to combine, according to the method of least squares, results of atomic weight determinations made by different chemical processes. The writer undertook such a discussion, as stated in his early memoir on the relations of the atomic weights, above referred to, but abandoned it simply because accidental errors are the only ones which such mathematical methods can eliminate, and these were found to be quite insignificant factors in the problem. No useful conclusion can be deduced by comparing different classes of results, each affected by unknown constant errors; for it is impossible to assign to them correct values, and in comparison with results from which constant errors have been eliminated they are worthless. For example, in the writer's published work on the atomic weight of antimony, although a closely accurate result was obtained by the synthesis of the sulphide of antimony, this result is of no value in comparison with that obtained subsequently from the analysis of bromide of antimony, and to assign it any value in a discussion of probable errors would lead to error.

If now the question is still pressed: what is the criterion of a pure and definite compound? the only explicit answer that can be given is that a substance obtained by repeated crystallisations offers the most uniformly satisfactory evidence of purity that we possess. It is well known, however, that repeated crystallisations will not always ensure purity, and that very frequently the crystals, though pure when formed, cannot be collected and preserved without change. Moreover, it is seldom the case that such repeated crystallisations are possible. In most instances we must rely on other criteria of purity, such as constancy of physical properties like the melting- or boiling-points, and often the question can only be answered by a special, frequently a difficult, investigation. Indeed herein lie the great obstacles which we meet in all attempts to fix with accuracy the values of the atomic weights, and good judgment is the only criterion on which we can always depend.

It is surprising how few substances fulfil the conditions required in an accurate atomic weight determination, rarely more than one compound of each elementary substance; and for some of the most common elements, so far as we yet know, not even one. After the process has once been worked out, the actual analytical work is generally readily accomplished and the accidental errors involved are comparatively small; and when the constant errors have all been eliminated the definiteness of the results is surprising; and cannot but produce in the analyst a confidence in the definiteness of the law which determines such effects. With the writer, while his earlier work on crystalline alloys left an impression of the possible indefiniteness (under certain conditions) of chemical combination, his later work on atomic weights has shown him the exceedingly definite aspects of the same phenomena. Moreover, he has not found any evidence that the definiteness of chemical combination diminishes as the

chemical force is weakened, a result we should expect if a variation were possible and as was predicted in the memoirs that have been so often cited. On the contrary, the writer has found that when purity is secured the proportions are as definite in weak compounds as in strong, in oxide of silver as in water; only with weak compounds it is usually more difficult to ensure purity.

While, therefore, the writer feels that the weight of evidence is at present in favour of the atomic theory, and of that absolute definiteness of combining proportions which this theory involves, still he is very glad that the whole question has been reopened in such an authoritative way as is likely to lead to its solution. His own investigations, now in progress, will have a direct bearing upon it, and until the requisite facts have been established there is no sufficient ground for a positive opinion. But, although it must be admitted that the atomic theory is the only basis on which a consistent philosophy of chemistry can at present be built, the writer must confess that he is rather drawn to that view of nature which refers all differences between substances to dynamical causes, and which regards the atomic theory as only a temporary expedient for representing the facts of chemistry to the mind.—*American Journal of Science.*

A RECALCULATION

OF

THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.
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PHOSPHORUS.

THE material from which we are to calculate the atomic weight of phosphorus is by no means abundant. Berzelius, in his *Lehrbuch*,† adduces only his own experiments upon the precipitation of gold by phosphorus, and ignores all the earlier work relating to the composition of the phosphates. These experiments we will consider with reference to gold.

Pelouze,‡ in a single titration of phosphorus trichloride with a standard solution of silver, obtained a wholly erroneous result; and Jacquelin,|| in his similar experiments, did even worse. Schrötter's criticism upon Jacquelin sufficiently disposes of the latter.§

There are, in short, but two investigations upon the atomic weight of phosphorus which have any value for present purposes, namely, the researches of Schrötter and of Dumas. These chemists worked with different materials and by different methods, and yet obtained beautifully concordant results.

Schrötter¶ burned pure amorphous phosphorus in dry oxygen, and weighed the pentoxide thus formed. One gram. of P yielded P₂O₅ in the following proportions:—

2.28909
2.28783
2.29300
2.28831
2.29040
2.28788
2.28848
2.28856
2.28959
2.28872

Mean 2.289186 ± 0.00033

Hence P = 30.9562 ± 0.0074.

* Smithsonian Miscellaneous Collections. "The Constants of Nature."

† 5th Ed., 1888.

‡ *Comptes Rendus*, 20, 1047.

|| *Comptes Rendus*, 33, 693.

§ *Journ. f. Prakt. Chem.*, 57, 315.

¶ *Journ. f. Prakt. Chem.*, 53, 435. 1851.

Dumas* prepared pure phosphorus trichloride by the action of dry chlorine upon red phosphorus. The portion used in his experiments boiled between 76° and 78°. This was titrated with a standard solution of silver in the usual manner. Dumas publishes weights, from which I calculate the figures given in the third column, representing the quantity of trichloride proportional to 100 parts of silver:—

1.787 grms. PCl ₃	=	4.208 grms. Ag	42.4667
1.466	"	3.454	" 42.4435
2.056	"	4.844	" 42.4443
2.925	"	6.890	" 42.4528
3.220	"	7.582	" 42.4690

Mean 42.4553 \pm 0.0036

Hence $P = 31.0314 \pm 0.0467$.

Now, combining these two values, we have:—

By Schrötter	$P = 30.9562 \pm 0.0074$
By Dumas	$P = 31.0314 \pm 0.0467$

General mean $P = 30.9580 \pm 0.0073$

If $O = 16$, this becomes 31.0292.

The fact here noticable, that Dumas' figures give a value for P slightly higher than that deduced from those of Schrötter, may be accounted for upon the supposition that the phosphorus trichloride contained traces of oxychloride. Such an impurity would tend to raise the apparent atomic weight of phosphorus, and its occurrence is by no means improbable.

A RECALCULATION OF THE ATOMIC WEIGHTS FROM THE ORIGINAL NUMBERS.†

LOTHAR MEYER, as he states in his preface to this work, had begun in 1867 to recalculate, according to a uniform method, all the determinations of atomic weights which had been made up to that time and were still serviceable; while K. Seubert has treated in the same way all those more recent than 1868, and has arranged for publication the whole of the material. Shortly before the completion of this laborious work, F. W. Clarke's book on the same subject appeared, but the authors believed, with justice, that this should not prevent the publication of their work; for not only is the manner in which they have arranged and set out their material totally different, but the results also are not in every case identical with those of Clarke, although in most instances they differ but little. The values which agree in the two books will therefore be all the more reliable.

In making the calculations the value of the individual experiments has been most carefully tested, and those not to be depended on or proved to be incorrect have been either altogether discarded or else not calculated out. The authors have also all through avoided the method of least squares, as being in most cases delusive. Where it was possible and seemed necessary the apparent weight obtained by weighing in the air has been reduced to the actual weight. There is, in conclusion, a synoptical table of all the calculations, together with short critical remarks on the value of the results obtained. The following is taken from these:—

On looking over the atomic weights it will be seen that the ratio of the two units O and H , and also the atomic weight of oxygen to 0.5 per cent, have been accurately determined. Should, however, this ratio be found at some future time to be incorrect, then all those numbers referred to H as unity would require to be changed accordingly.

The following table contains the most reliable figures; and all values whose possible error lies between 0.01 and 0.5 H are denoted by (a):—

NAME AND SYMBOL.		$O = 1.$	$H = 1.$
Aluminium.....	Al	a 1.694	a 27.04
Antimony	Sb	7.494	119.6
Arsenic	As	a 4.693	a 74.9
Barium	Ba	a 8.575	a 136.86
Beryllium	Be	a 0.569	a 9.08
Bismuth	Bi	13.00	207.5
Boron	B	a 0.683	a 10.9
Bromine	Br	a 4.997	a 79.76
Cadmium	Cd	a 7.00	a 111.7
Cæsium	Cs	a 8.315	a 132.7
Calcium	Ca	a 2.501	a 39.91
Carbon	C	a 0.7502	a 11.97
Cerium	Ce	8.847	141.2
Chlorine	Cl	a 2.2159	a 35.37
Chromium	Cr	3.284	52.45
Cobalt.....	Co	3.67	58.6
Copper	Cu	a 3.959	a 63.18
Decipium	Dp	?	?
Didymium.....	Di	9.09	146.0
Erbium	E	10.4	166.0
Fluorine.....	F	a 1.194	a 19.06
Gallium	Ga	a 4.38	69.9
Gold	Au	12.29	196.2
Hydrogen	H	a 0.06265	a 1.00
Indium	In	a 7.108	a 113.4
Iodine	I	a 7.9284	a 126.54
Iridium	Ir	a 12.06	a 192.5
Iron	Fe	a 3.501	a 55.88
Lanthanum	La	8.680	138.5
Lead	Pb	a 12.932	a 206.39
Lithium.....	Li	a 0.439	a 7.01
Magnesium	Mg	1.500	23.94
Manganese	Mn	3.43	54.8
Mercury	Hg	a 12.52	a 199.8
Molybdenum	Mo	a 6.01	a 95.9
Mosandrium.....	Ms	?	?
Nickel	Ni	3.67	58.6
Niobium (Colum- bium, Cb)	Nb	5.87	93.7
Nitrogen	N	a 0.8779	a 14.01
Norwegium	Ng	?	?
Osmium	Os	12.2	195
Oxygen	O	a 1.00	a 15.96
Palladium.....	Pd	6.66	106.2
Phosphorus	P	a 1.940	a 30.96
Platinum	Pt	a 12.177	a 194.3
Potassium.....	K	a 2.446	a 39.03
Rhodium	Rh	6.52	104.1
Rubidium	Rb	a 5.34	a 85.2
Ruthenium	Ru	6.49	103.5
Samarium ($Y\beta$?) ..	Sa	?	?
Scandium.....	Sc	a 2.755	a 43.97
Selenium	Se	a 4.942	a 78.87
Silicon	Si	1.754	28.0
Silver	Ag	a 6.7456	a 107.66
Sodium.....	Na	a 1.4408	a 22.995
Strontium	Sr	a 5.47	a 87.3
Sulphur.....	S	a 2.0037	a 31.98
Tantalum.....	Ta	11.42	182
Tellurium.....	Te	8.00	127.7*
Terbium	Tb	?	?
Thallium	Tl	12.76	203.7
Thorium	Th	14.534	231.96
Thulium	Tm	?	?
Tin	Sn	7.353	117.35
Titanium	Ti	3.15	50.25
Uranium	U	15.03	239.8
Vanadium	V	a 3.20	a 51.1
Wolfram(Tungsten)	W	a 11.50	a 183.6
Y α and Y β		?	?
Ytterbium.....	Yb	10.81	172.6
Yttrium.....	Y	5.61	89.6
Zinc	Zn	4.065	64.88
Zirconium	Zr	5.66	90.4

* Perhaps $Te = 7.91; 126.3$.

* Ann. Chem. Pharm., 113, 29. 1860.

† "A Recalculation of the Atomic Weights from the Original Numbers," by Lothar Meyer and K. Seubert. Leipsic: 1883.

Among the atomic weights are some where the possible error does not exceed one to two-hundredths that of hydrogen, viz.:—

Na, K, Ag, C, N, O, S, Cl, Br, I.

Not exceeding 0.1 H:—

Li, Rb, Ca, B, Pb, P, V, S, Se.

Exact to at least 0.5 H:—

Cs, Cu, Be, Sr, Ba, Cd, Hg, Al, Sc, Ga, In, As, Se, Mo, W, Ir, Pt.

Incorrect from a half to a whole unit:—

Au, Mg, Zn, Si, Te, Cr, Mn, Co, Ni, Ru, Rh, Pd.

While, leaving out of account several very doubtful earth metals, we have the following in which the error may amount to several units (sometimes 20):—

C, La, Di, Y, Yb, E, Tl, Ti, Zr, Th, Sn, Sb, Nb, Ta, Bi, U, Os.

NOTICES OF BOOKS.

Plant Analysis: Qualitative and Quantitative. By G. DRAGENDORFF, Ph.D., Professor of Pharmacy in the University of Dorpat. Translated from the German by H. G. GREENISH, F.T.C. London: Baillière, Tindall, and Cox.

WE have here a work of such exceptional value that it may well be said to "supply a want keenly felt by both English chemists and English Pharmacists."

The author's merit in this particular department of chemical science is well known to all who have had occasion to make use of his procedures for the detection of organic poisons, and we may therefore congratulate ourselves that his work has been made available to English students and experts in the present clear and accurate translation.

Professor Dragendorff fully recognises the difficulties of his subject as compared with mineral analysis. Nevertheless he has felt warranted in attempting the construction of a method that shall comprise at once both the qualitative and the quantitative, the micro- as well as the macro-chemical analysis of plants and their constituents. All widely distributed vegetable substances are to be included, the detection of rarer ones facilitated, and the method so arranged that other principles not hitherto observed shall, if present, attract the attention of the investigator.

The author agrees with earlier authorities in this department of analysis in separating the principles present into groups by the successive use of different solvents. He admits also that these solvents should be as indifferent as possible, but he increases their number and varies the order of their application.

Professor Dragendorff gives at the outset instructions for drying and pulverising—processes more difficult in this case than with inorganic matter, and for the determination of the ash.

He then proceeds to the successive application of the solvents. Petroleum spirit is first used to remove ethereal and fatty oils, wax, &c. Next follows ether—as free as possible from water and alcohol—in order to take up the resins and their allies. The residue is then treated with absolute alcohol in order to dissolve out tannins, bitter principles, alkaloids, &c. Next follows water which removes mucilage, saponin, acids, glucoses, and saccharoses. Afterwards comes treatment with dilute soda in order to extract metarabic acid, the albumenoids, phlobaphene, &c. Dilute hydrochloric acid is next used to remove starch, parabin, calcium oxalate. Lastly comes the estimation of lignine and its allies and of cellulose.

The precautions to be taken in the use of the various solvents are explained in full, and instructions are given for separating the members of each group.

The remaining and larger portion of the work is devoted to special methods and supplementary notes. We may obtain a fair notion of the thoroughness of Prof. Dragendorff's instructions by looking a little more closely at the section on the estimation of tannin, and the supplemental remarks on the same subject. The author passes in review the process of Pribram, with neutral lead acetate, which yields a precipitate not of constant composition, though if the solution is not over-dilute and the washing is not too prolonged the tannin in sumac, divi-divi, myrobalans knopperrn, oak-bark, and willow-bark "may generally be satisfactorily estimated. Gallo-tannic acid at times also yields good results."

Sackur's method with copper acetate gives inconstant results even with the same tannic acid. Stannous chloride and ammoniacal stannous chloride, recommended by Risler-Beunat and Persoz, precipitate most tannins slowly and incompletely. Tartar emetic, recommended by Gerland, for the volumetric determination of tannin, does not precipitate some forms of tannin at all. Ammoniacal solution of zinc acetate, ferric acetate, and ferric citrate, as proposed by Terreil, Handtke, and Wildenstein, fail also to give generally satisfactory results. Löwenthal's permanganate process yields results which are sufficiently accurate for technical purposes, though the solution must be very dilute. The chloride of lime process of the same author shows results in excess of the truth.

Mittenzwey's method, based on the absorption of oxygen by an alkaline solution of tannin, is rarely of any value. Wagner's method,—titration with cinchonine sulphate, using rosaniline acetate as an indicator—has, in the hands of most experimentalists, failed to give good results, as its fundamental assumption that magenta does not colour the liquid until all the tannin has been precipitated, does not hold good of all tannins. The gelatin process, with the addition of common salt and 1-10th vol. of hydrochloric acid (of sp. gr. 1.12), is sometimes available, but the proportions of tannin precipitable by 100 parts of gelatin, vary from 77 to 168. Attention is called to the fact that, under the name of tannin, are included bodies differing in their molecular weights, in their chemical effects, and in their constitutions. Some are decidedly glucosides and others decidedly not. The author advises that this point should always be carefully determined in tannins found on examining any unknown vegetable product.

The alkaloids, we need scarcely say, are worked out in a very elaborate manner. In the separation and recognition of the vegetable acids the author adopts to a great extent the methods recommended by Barfoed.

Cellulose Prof. Dragendorff does not consider to be absolutely invariable in its composition and properties. The cellulose of most phanerogamous plants is dissolved by ammonio-sulphate of copper (prepared by precipitating hydrate of copper from the solution of the sulphate by dilute caustic soda, rapidly filtering, pressing, and dissolving in the requisite quantity of 20 per cent solution of ammonia), but that of many fungi is either insoluble or taken up to a very slight extent only.

Among the useful features of this book must be mentioned a table of the empirical formulæ, and percentage composition of the vegetable constituents mentioned in the body of the work; another table of the more important of the same bodies, arranged according to their percentage of carbon, beginning with the lowest, a plate showing the spectra of the most important vegetable colouring matters, and a good index.

This book will speedily be recognised as an invaluable guide both in the chemical and the pharmaceutical laboratory.

Wheat from India.—M. Balland.—The author has found in sacks of wheat exported from Bombay a quantity of seeds, principally *Vicia peregrinum*, *Cicer arietinum*, and *Ervum uniflorum*.—*Comptes Rendus*.

CORRESPONDENCE.

CHEMICAL RESEARCH IN ENGLAND.

To the Editor of the Chemical News.

SIR.—The article on "Organic Chemistry," in *Nature* of Oct. 25th, must have set the minds of many chemists thinking over the present and future prospects of this science in England.

The author, however one-sided his views, points out clearly the want of original research in England. I should be obliged if you could find space for some remarks on this subject from one who has devoted some thought to it. The majority of English chemists, the younger men more especially, have to live by the pursuit of chemistry, either in teaching it, in applying it to the arts and manufactures, or as professional chemists. What benefit, at the present day, will either of these derive from, or what honour gain by original research? Little or none.

First, with regard to the teacher. The appointments of lecturer or teacher of chemistry at the Universities, Hospitals, and the Public Schools are always given to men who have a degree rather than to men who have shown any power of original research. If original research were made a *sine qua non* of a degree one could understand this. Many practical chemists know that men holding high honours in chemistry are often unable to perform even simple laboratory experiments. They know how to use their memories, but their hands are strangers to them. These examination men are the teachers of the present generation; they have done no original research, and they do not see the value of it. They have learnt or crammed what has been done in the past, and then start to teach or cram others. So original research and its value as an educational agent is ignored.

Secondly, as regards the practising chemist, whether in the arts or manufactures or as independent professional men. Most of these can claim only the letters F.C.S. after their name to distinguish them, and as this F.C.S. can be easily obtained by any man truly interested in chemistry, it has no value as a mark of distinction. Why does not the Chemical Society make a distinction between the Fellow who has done original research, and the man who is amply repaid for his subscription by the *Journal* and other advantages the Society offers? Then F.C.S. would be of value, and original research in England have a great stimulus given to it.

Nevertheless, I believe there is far more original research done in England than is generally supposed, but it is not made known, being applied quietly and privately to our arts and manufactures.

The author of the article does, unwittingly we must presume, great injury to English chemists. He tends to increase the notion, already too prevalent, that Germans are superior chemists to Englishmen. Already many of the best appointments in England are given to Germans, instead of to English chemists, and much original work done in England goes to swell German periodicals. I may be accused of partiality, but I believe that Englishmen are as good chemists as Germans. There are many English chemists who, finding that English appointments are given by preference to German Ph.D's, have transferred their energies into less biassed professions or businesses.

Whilst holding the strongest views as to the value of original research, I should be sorry to see English chemists following the example of the Germans. Much of the original research of German chemists is most trivial. An infinite number of minute points are dilated to an abnormal bulk. This does not represent true work, nor does it tend to those broad generalisations so desired, and the reduction of chemical facts to a manageable and intelligible form.

The Government, the Royal and Chemical Societies,

and the British Association, all lend aid to promote original research. I cannot but think it a mistake that much of this money goes to men already in the receipt of good incomes, or even of independent means. These men ought surely to need no inducement to make them devote some of their time and means to original research. If the grants of money were in all cases £100 per annum given to younger men not making sufficient incomes to keep them, and at the same time enable them to devote time to original research, more work might be done, and with care in selecting men of ability good work would be also ensured.

I must apologise for thus trespassing on your space, but this subject is one, I believe, of importance to the scientific, educational, and industrial classes in England.—I am, &c.,

FREDK. JAS. LLOYD, F.C.S.

King's College,

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvi., No. 15, October 8, 1883.

Force of Explosives.—M. Berthelot.—The author gives a notice of a work which he has just published, and which gives a general theory of explosives, according to their chemical metamorphosis and their formation-heat.

The Co-existence, in a Specimen of Guano, of Ammonium Carbonate effervescing with Water and of Potassium Sulphate.—E. Chevreul.—The author thinks that sodium chloride, and especially potassium chloride, which he has found associated with ammonium hydrochlorate, may have an important influence upon vegetation.

Induction produced by the Variation of Intensity of the Electric Current in a Spherical Solenoid.—M. Quet.—A mathematical memoir, not capable of useful abstraction.

Products of the Fermentation of Cane-sugar induced by Arable Soil.—MM. Dehérain and Maquenne.—The ferments of arable soil acting upon cane-sugar at 35° in presence of calcium carbonate and with the exclusion of air furnish the following products:—Small quantities of ethylic alcohol and traces of the higher alcohols. Certain proportions of acetic, butyric, and propionic acids, the two former much more abundant than the latter.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin. Vol. 16, No. 3.

Action of Phosphorus Chlorides upon Phenanthren-quinone.—B. Lachowicz.—Phosphorus pentachloride yields, with phenanthren-quinone, a new substance, phenanthren-dichlor-keton, $C_{14}H_8OCl_2$, besides phosphorus oxychloride and a resinous substance. Phosphorus trichloride yields also a new substance if allowed to act upon phenanthren quinone, but the author has not yet obtained it in sufficient quantity.

Allyl-succinic Acid and a Carbo-capro-lactonic Acid.—E. v. Hjelt.—The author obtains allyl-succinic acid from malonic ester. It closely resembles the propyl-succinic acid of Waltz.

Kreatinoid Compounds of the Aromatic Group.—Peter Griess.—An examination of the products obtained by the action of cyan-carbimid-amido-benzoic acid upon the aromatic amido and diamido compounds.

Preparation of Diphenylen-keton-oxide.—W. H. Perkin.—The author obtains this compound from the residue of the distillation of a mixture of salicylic acid with acetic anhydride.

The Diazo-derivatives of Nitro-benzyl-cyanide.—W. H. Perkin.—The author has obtained a compound, $C_{14}H_{10}N_4O_2$, by treating an alcoholic solution of nitro-benzyl-cyanide with alcoholic potassa, and adding an aqueous solution of diazo-benzol-chloride.

Molecular Magnitude of Iso-indol.—F. P. Treadwell and V. Meyer.—The authors obtained the figures 7.99 and 7.91, which agree with no formula.

Sulphocyan-propimine.—J. Tscherniac and C. H. Norton.—This compound is obtained by dissolving two parts ammonium sulphocyanide in 6 parts of hot ammonia at 90 per cent, adding 1 part of mono-chlor-acetone, and letting the mixture stand twenty-four hours. It is then filtered, washed with absolute alcohol, and the filtrate is distilled in the water-bath. The residue is dissolved in 4 parts of cold water, and allowed to stand for some days. The red liquid is freed from sediment by decantation, decolourised by repeated boiling with bone-black, and concentrated at 110° . The sulphocyanate of the base crystallises out.

Sulphocyan-acetone.—J. Tscherniac and R. Hellon.—The authors dissolve 175 parts of crystalline barium in 525 parts of alcohol, and add 100 parts of mono-chlor-acetone. After some days the mixture is filtered, the deposit washed with alcohol, the alcoholic liquid is concentrated on the water-bath, and leaves crude sulphocyan-acetone as a syrup. This is boiled in 10 parts of water; the solution is let stand twenty-four hours, when a thick stratum of tarry matter is deposited. The clear solution is decanted off, filtered, and concentrated on the water-bath. Sulphocyan-acetone falls to the bottom in the state of oily drops, and is washed with a little distilled water, and dried in a vacuum over sulphuric acid.

A New Industrial Method of obtaining Whole-stuff.—G. Archbold.—The author macerates wood or straw, cut into suitable pieces, in dilute milk of lime, after twelve hours introduces them into a suitable digester, and saturates with sulphurous acid, the pressure amounting to four or five atmospheres. In two hours the material is so loosened up that after washing with water and further treatment under pressure with 3 per cent chloride of calcium and half per cent aluminium sulphate dissolved in a little water, the stuff obtained without any further operation has the appearance of cotton, and can serve for the manufacture of fine qualities of paper.

The Occurrence of Methyl Alcohol among the Products of the Dry Distillation of Resin.—W. Kelbe and J. Lwoff.—From 150 kilos. of resin the authors obtained 50 grms. of methyl alcohol.

The Conversion of the Nitriles into Imides. Behaviour of Hydrocyanic Acid and Ethylene Cyanide with Hydrochloric Acid and Alcohol.—A. Pinner.—On passing gaseous hydrochloric acid into a mixture of equivalent quantities of a nitrile and an alcohol, there is formed an amido-chlor-ether. This compound is very unstable, loses a molecule of hydrochloric acid, and is quickly converted into the hydrochlorate of the imido-ethers. The author has especially studied the formation of formimido-ether and succinimido-ether.

On I. IV. Diortho-nitro-anthraquinone, I. IV. Diortho-amido-anthraquinone, and a New Method for Preparing Anthra-rufine.—H. Roemer.—For preparing anthra-rufine the dimido-compound is dissolved in an excess of concentrated sulphuric acid, water is added until a red paste is formed. When cold, potassium nitrite is added till a clear yellow solution appears, and the odour of nitrous acid is distinct. It is let stand a short time, diluted with water, and boiled, when dark yellow flocks are soon separated, with escape of gas. After boiling for about an hour the conversion is complete.

The yellow compound dissolves almost completely in potassa with a reddish yellow colour. For further purification it is precipitated with hydrochloric acid; the precipitate boiled in baryta-water, and the crimson lake thus formed, is decomposed with hydrochloric acid. A pure, orange-yellow, crystalline product is thus obtained.

A New Non-saturated Acid Isomeric with Itaconic Acid.—R. Fittig and F. Roeder.—The authors caused ethylene bromide to act upon sodium malonic ether, and obtained the above acid, which melts at 139° .

Conversion of Non-saturated Acids into Isomeric Lactones.—R. Fittig.—This transformation is readily effected if the non-saturated acid is heated for a short time with dilute sulphuric acid.

Behaviour of the Lactones with Water.—R. Fittig.—The distinction between the author's δ -lactones and the ordinary lactones is not quite so great as he at first supposed. The latter, also, if boiled for some hours in a very dilute solution in a cohobator, yield an acid liquid, a part of the lactone being converted into the corresponding γ -oxy-acid.

Amido-phenoles.—F. Kalckhoff.—The author has obtained and analysed ortho-oxy-phenyl-urea and the corresponding para compound.

Moniteur Scientifique, Quesneville.
October, 1883.

Patents taken Abroad.—Specifications of German patents relating chiefly to colouring-matters.

Panary Fermentation.—G. Chicandard.—The author concludes that panary fermentation does not consist in a hydration of starch followed by alcoholic fermentation. It is not determined by a *Saccharomyces*. The fermentable matter is the gluten which is rendered available for the microbia by means of a zymase which they secrete. This zymase renders it at first soluble, and then converts it into a peptone by hydration. The microbia assimilate this peptone, furnishing numerous products of excretion, carbonic, acetic, butyric, and lactic acids, hydrogen, nitrogen, alcohol, leucine, tyrosine, and phenol. Crude starch is not modified, either by the microbia or by their zymase; baking alone forms soluble starch, erythro-dextrines, and achroo-dextrines. These latter are found especially in the parts which have been most strongly heated. The agent of panary fermentation exists normally in the grain of wheat as a mobile sphaero-bacterium, *Microzyma glutinis*. It develops into *Bacillus glutinis*, and this change is accelerated by the soluble albumenoid matters which baker's yeast contains. Panary fermentation is produced whenever flour mixed with leaven or yeast is brought in contact with water.

Picric Acid employed as a Reagent for Albumen and Sugar in Urine.—Dr. G. Johnson.—From the *Pharmaceutical Journal*.

The Resin Industry in the Landes.—A. Renard.—An interesting monograph, topographical, technical, and scientific, but too bulky to admit of abstraction.

Review of Foreign Researches in Organic Chemistry.—G. de Bechi.—A series of extracts from the *Berichte der Deutsch. Chem. Gesell.*

New Process for the Manufacture of Stuff for Paper.—L. Naudin.—This memoir consists essentially in an illustration showing the plant employed.

New Steam Bronze.—M. Balanche.—On adding a solution of potassium bichromate to one of manganese chloride, no precipitate is obtained, but if the neutral chromate is used there is an immediate bronze precipitate. Setting out with these facts the author has made up a colour with a mixture of potassium bichromate, manganese chloride, and sodium acetate. By the action of heat the sodium acetate is decomposed, the acid chromate neutralised, and the precipitate mentioned above is formed upon the cloth. The colour employed was:—

Bichromate	100 grms.
Water	850 "
White starch	150 "

Boil, let cool, and add :—

Crystalline manganese chloride ..	210 "
Sodium acetate, 16½° B.	210 "

The colour, when printed and steamed, gave a very intense bronze, scarcely affected by washing and soaping. The cloth was not affected. The same mixture, leaving out the starch, may be used for steeping cloth, and thus produces a bronze, which may be discharged by tin crystals and an acid. The author enquires whether the bronze is manganese peroxide or a sub-chromate.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome x., August, 1883.

This number is chiefly taken up with the announcement of prizes offered for inventions. Among these we find the moderate sum of 2000 francs proposed for the industrial application of oxygenated water; the same sum for the economic preparation of ozone; the same sum (!) for the fixation of the nitrogen of the air in the form of nitric acid, ammonia, or cyanogen; the same sum for the production from pyrites of sulphuric acid, absolutely free from arsenic. 1000 francs for a new industrial use of any cheap and plentiful mineral; the same sum for the utilisation of industrial residues; the same sum for a useful application of the newly discovered metals; the same sum for the new applications of non-metallic bodies, and the same sum for the discovery of a new alloy useful in the arts. Further, 3000 francs for the artificial production of graphite fit for pencils; the same sum for the artificial production of black compact diamond; 4000 francs for the discovery of processes capable of furnishing useful organic compounds, such as quinine, cane-sugar, &c.; 4000 francs for the artificial preparation of fatty acids or waxes; 1000 francs for improvements in the production and working of kelp-ash; 3000 francs for the production of steel or melted iron having special useful properties, by the incorporation of foreign metals. 2000 and 1000 francs respectively for the manufacture in France of fuming sulphuric acid and anhydrous sulphuric acid; 3000 francs for the utilisation of naphthalene in the manufacture of colours; 2000 francs for the substitution in dyeing, and especially in silk dyeing, of some non-destructive compound for sulphuric acid; 2000 francs for the discovery of a process for the utilisation of the tannin contained in barks, &c., not used in tannery, and 2000 francs for the industrial preparation of chlorine from the residues of the ammonia soda process.

NOTES AND QUERIES.

* * Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Narcotic.—Perhaps some kindly disposed reader would give me a rapid and reliable method for the estimation of morphia and narcotine in opium. The only methods I know of require about two days to complete.—J. F.

Detection of Traces of Gold.—Would any of your readers be kind enough to tell me what is, or where I can find an account of, the best method of detecting small traces of gold in the presence of large quantities of iron?—J. C.

MEETINGS FOR THE WEEK

MONDAY, November 5th.—Royal Institution, 5. General Monthly Meeting.

SATURDAY, 10th.—Physical, 3. "Some Experiments on the Velocity of Sound in Air," by J. Blaikley. "On the Moment of a Compound Magnet," by R. H. M. Bosarquet. "On Measurements relating to the Electric Resistance of the Skin, and to certain Medico-electric Appliances," by W. L. Carpenter

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Steam Sulphur Melter.
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Wheels, Bevel Mitre, and Spur Moulded on the Shortest Notice Patent Machinery.
by Makers of Alizarine Plant, Jones and Walsh's Patent Sulphate of Soda Furnace, Kynaston's Patent Alum Plant, Macfear's Patent Carbonating Furnace, and Parnell and Simpson's Patent Causticiser,

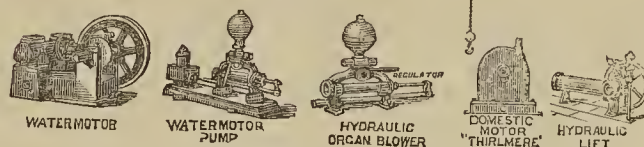
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A 20-horse Water Motor, pumping for H. Vivian, Esq., M.P.
A 12-horse Water Motor, pumping at the Mine of G. N. Newdegate, Esq., M.P.

TESTIMONIALS.

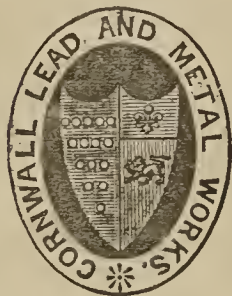
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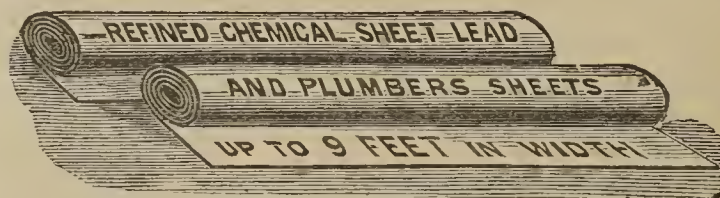
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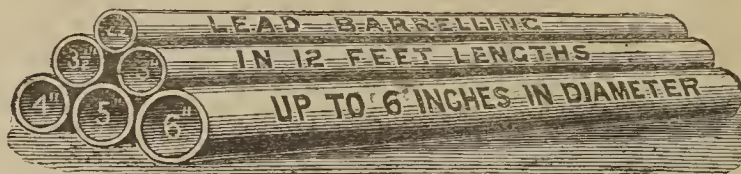
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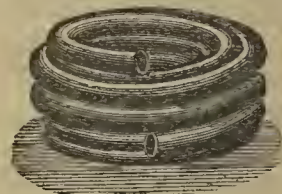
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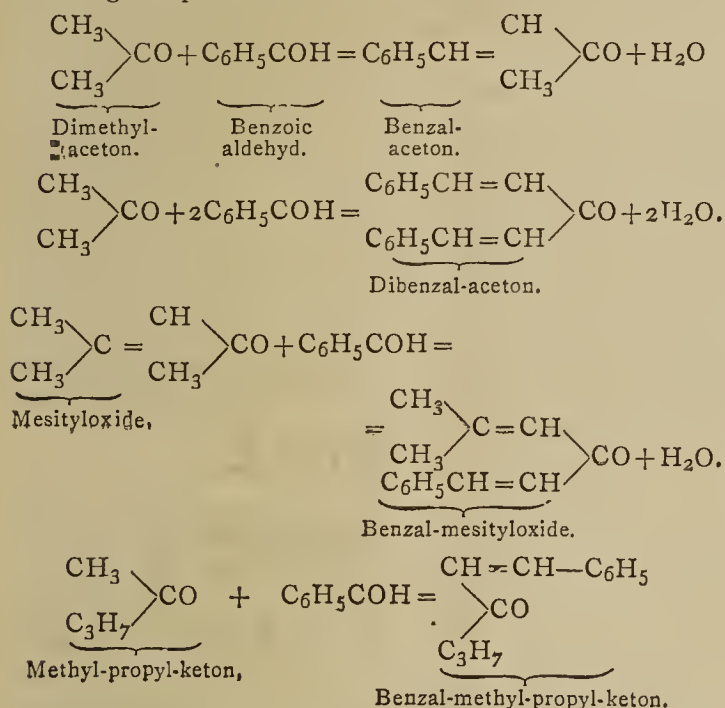
THE CHEMICAL NEWS.

VOL. XLVIII. No. 1250.

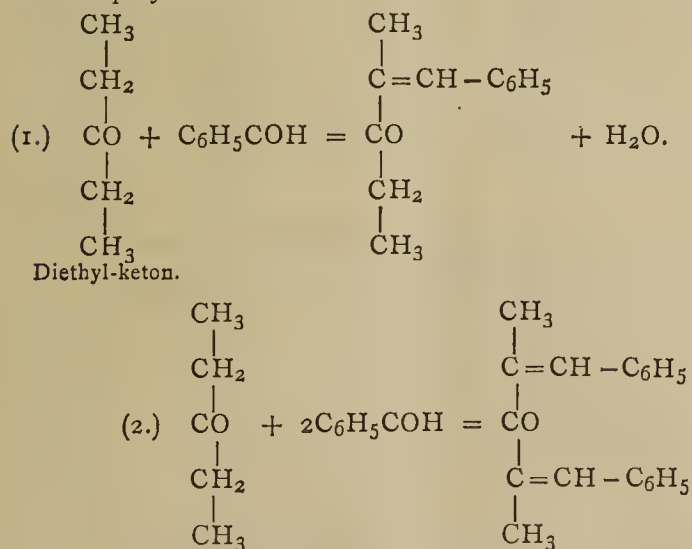
ON FURTHER CONDENSATION COMPOUNDS OF KETONES AND ALDEHYDS.

By A. C. PONDER.

THE examination of the condensation-products of aldehyds and ketones undertaken by Dr. Claissen,* Claparède,† and myself have shown that in ketones in which a CH₃ group is directly united to CO, a displacement of the elements of water readily takes place when the ketone is brought into contact with an aromatic aldehyd and a dehydrating agent. We obtained thus the following compounds:—



It became then interesting to study the behaviour of ketones containing the radicle R—CH₂—CO—CH₂—R, e.g., diethyl-ketone and dipropyl-ketone, to find, in fact, if the CH₂ or methylene group behaved as a CH₃ or methyl group, by which one would arrive at the following compounds, accordingly as one or two molecules of the aldehyd were employed.



* Berl. Berichte. i., 349.

† Ibid., ii. 2460.

In my experiments with Dr. Claissen, a solution of soda as dehydrating agent was made use of containing 10 per cent of the alkalis, and the ketone and aldehyd were dissolved in diluted alcohol. This reacted in nearly all cases most successfully, the oily body which at first separated becoming hard and crystalline after the lapse of a few hours.

In applying the same means of condensation to a solution of dipropyl-ketone and benzoic aldehyd in weak alcoholic solution the same reaction was observed, but on attempting to distil the oily body, which after many days had not become solid, decomposed into its constituents even when the distillation was conducted under diminished pressure. In employing hydrochloric acid gas we obtained somewhat better results, but the compound was very impure, and unfit for analysis.

I have, however, recently obtained conclusive evidence that a condensation takes place when sulphuric acid is employed as a dehydrant.

In my experiment I took diethyl-ketone (which is the more easily prepared of the two) and benzoic aldehyd in the proportion of two molecules of the aldehyd to one of the ketone. I dissolved both in a slight excess of glacial acetic acid, placed the vessel in a freezing mixture, and allowed strong sulphuric acid to drop slowly into it from a tap funnel, stirring the mixture all the time. There ensued at once a dark brown colouration, and the whole became gradually very thick and viscous. After standing some time it was poured into cold water, neutralised with soda, and ether added in excess. The ethereal solution was distilled to free it from the ether, and the oily red-brown liquid which remained behind left to itself. After some days I found that a mass of small scaly crystals had separated from the oil. These I collected together, and washed with ether. The melting-point was 107°. The amount, however, was unfortunately too small for analysis. I hope to experiment further on larger amounts, and satisfactorily isolate the compound.

ON THE ESTIMATION OF PHOSPHORIC ACID AS MAGNESIC PYROPHOSPHATE,

AND THE

INFLUENCE OF CERTAIN REAGENTS EMPLOYED IN SEPARATING THE ACID FROM BASES.

By DAVID LINDO.

MICROCOSMIC salt has been employed by me in this investigation. It can be purchased in a state of great purity, it can be accurately weighed, and the solution has no action on glass vessels. The water of crystallisation is a slight drawback.

If the salt is crushed, pressed between folds of filter-paper, and preserved in an accurately ground stoppered bottle, the stopper greased, constant results will be obtained with it for some time, but after a few months, if the bottle has been frequently opened, the phosphoric acid will come out on analysis a little too high, showing loss of volatile constituents has taken place.

Making up large volumes of solution was not found to answer, as whatever care was taken to preserve them they varied in strength before they were used up.

The salt employed was submitted to careful qualitative analysis, and I could detect no impurity; it was in the form of small crystals mostly detached, but partly aggregated in lumps.

A portion crushed fine and pressed between folds of filter-paper was weighed in a porcelain crucible; weight, 1.6528 grms.; left in open crucible on balance pan for 20 minutes, lost 0.0002 grm.; the total loss in one hour was only 0.0004 grm.

According to the atomic weights adopted by Miller, microcosmic salt on ignition should leave 48.8 per cent sodic metaphosphate and contains 33.97 per cent phosphoric acid. 1.3735 grms. of the salt in its original condition ignited carefully in a Lawrence Smith crucible to constant weight, left a residue weighing 0.6698 gm. Theory requires 0.67027 gm.

A portion of the salt crushed and pressed, weighing 1.365 grms., ignited as above, left 0.6664 gm. residue. Theory requires 0.66644 gm.

A considerable quantity was crushed fine, pressed between folds of filter-paper, well mixed, and bottled Dec. 10th, 1882.

Another portion was crushed only, mixed and bottled December 24th, 1882.

A further portion was turned into a mortar, the lumps broken down, well mixed, and bottled April 29th, 1883.

Previously (November and April) some estimates were made with the salt in its original condition and with a small quantity that had been crushed and pressed.

I shall refer to the above as—

The salt crushed and pressed.

The salt crushed only.

The salt bruised and mixed.

The salt in its original condition.

In the earliest stage of the enquiry a large number of the experiments were made (most of them with another sample of microcosmic salt) which with few exceptions proved unreliable, sufficient precautions not having been taken to exclude error. As nearly all the work was gone over again, I shall only refer to the *results* of such of these earlier experiments as can be depended on.

The results recorded in this paper could not be conveniently arranged in the order in which they were obtained, but I have annexed the date when the experiments were made to each series.

Two ignition experiments made January 21st, 1883, with the salt crushed and pressed December 10th, 1882, gave the following results:—

No. 1. Salt taken, 1.9719 grms.: residue, 0.9624 gm. = 33.97 per cent P_2O_5 .

No. 2. Salt taken, 1.9335 grms.: residue, 0.9440 gm. = 33.99 per cent P_2O_5 .

Balances Employed.

A large Oertling, to carry one kilogramme and turning distinctly with 1 milligramme, used to weigh the solutions.

A smaller Oertling, to carry 100 grms. and turning distinctly with 1-tenth of a milligramme, used to weigh the salt and precipitates. Both very fine instruments in excellent order.

Reagents Employed.

These were very pure.

Magnesia Mixture No. 1.

1 c.c. contained—

0.0156 gm. magnesium chloride.

0.0825 gm. ammonium chloride.

0.0194 gm. ammonia (NH_3).

Magnesia Mixture No. 2.

1 c.c. contained—

0.0312 gm. magnesium chloride.

0.1650 gm. ammonium chloride.

0.0127 gm. ammonia (NH_3).

Neutral Magnesia Mixture.

Made by heating a measured quantity of Mg. Mix. No. 1 to expel free NH_3 and making up to original volume with water.

Dilute Ammonia.

*No. 1 contained 6.34 per cent NH_3 .

No. 2 „ 2.52 per cent „

No. 3 „ 1.20 per cent „

* Having started with these strengths, I kept to them. Every fresh bottle of strong ammonia opened was titrated with normal HCl and diluted to the above standards.

Stronger solution of ammonia containing 11.54 per cent NH_3 .

Ammonium chloride.

Ammonium sulphate.

Ammonium oxalate.

Citric acid, a very fine sample.

Sol. ferric chloride, containing excess of HCl. 10 c.c. gave 0.0322 gm. ferric oxide, and contained total Cl sufficient to form 0.1580 gm. NH_4Cl .

Sol. aluminum chloride, containing excess of HCl. 10 c.c. gave 0.0225 gm. alumina, and contained total Cl sufficient to form 0.1839 gm. NH_4Cl .

Gooch's method of filtration was employed. Dimensions of perforated crucibles:—Height, 1 inch; diameter at top, 1 inch; diameter at bottom, $\frac{5}{8}$ inch. Each perforated crucible was provided with a plain one to serve as a jacket; the two with cover weighed 25 to 26 grms. All weighings and ignitions were made with the jacket on. The asbestos used was a fine picked sample obtained from Townson and Mercer. It was purified as usual by boiling in HCl solution, washed, dried, ignited over the blast to constant weight, and kept in distilled water. The same felting can be used repeatedly. In making a large number of estimates this is of considerable importance, for when the felting is new the filtrate is apt to be slightly turbid, requiring to be returned once or twice; if the felting has been once used this does not occur. After removing the bulk of the precipitate, a soft dry cloth is used to rub the inside of the crucible; the latter is then inverted and struck gently on the palm of the hand to remove loose particles. If the felting drops out, replace and mend it under suction, which does not take a minute. Particles still adhering firmly are of course included in the tare.

Except when otherwise stated, the experiments extending over more than a year were made at the temperature of the Laboratory, 25° to 32° C.

Experiments with the Solid Salt Method.

The quantity taken for each estimate was about 0.3766 gm. This should give 0.2 gm. magnesian pyrophosphate. Dissolved in 100 c.c. water. Added 12 c.c. Mg mix. No. 1, about 2 c.c. at a time, stirring well after each addition. When the precipitate had settled, added 10 c.c. No. 1 NH_3 . Let rest about ten hours.* Filtered, using the mother-liquor to rinse the beaker, and a trimmed feather to clean it. Washed with 200 c.c. No. 3 NH_3 . Ignited over Berzelius lamp fed with strong spirit; when quite cold weighed; no desiccator required.

February, 1883. Series A.

Made with the salt crushed and pressed December 10th, 1882.

No. of Expt.	Weight of Salt in grms.	$Mg_2P_2O_7$ required.	$Mg_2P_2O_7$ found.	P_2O_5 found for 100 pts. taken.
A 1	0.3765	0.2000	0.2000	100.00
2	0.3755	0.1994	0.1994	100.00
3	0.3753	0.1993	0.1997	100.20
4	0.3766	0.2000	0.2000	100.00
5	0.3760	0.1997	0.1995	99.90
6	0.3764	0.1999	0.1998	99.95

Average .. 100.01

February, 1883. Series B.

Made with the salt crushed only December 24th, 1882.

No. of Expt.	Weight of Salt in grms.	$Mg_2P_2O_7$ required.	$Mg_2P_2O_7$ found.	P_2O_5 found for 100 pts. taken.
B 7	0.3759	0.1996	0.1996	100.00
8	0.3764	0.1999	0.2000	100.05
9	0.3762	0.1998	0.2002	100.20
10	0.3773	0.2004	0.2005	100.05
11	0.3768	0.2001	0.2000	99.95
12	0.3782	0.2009	0.2009	100.00

Average .. 100.04

* This was unavoidable. I had to allow the same time before filtering in all the experiments. It has been repeatedly shown by others a much shorter time will suffice.

March, 1883. Series C.

Made with the salt crushed and pressed December 10th, 1882. In these experiments the Mg mixture was delivered from a burette, one drop a second, with constant stirring.

No. of Expt.	Weight of Salt in grms.	Mg ₂ P ₂ O ₇ required	Mg ₂ P ₂ O ₇ found	P ₂ O ₅ found for 100 pts. takn.
C 13	0.3762	0.1998	0.1995	99.85
14	0.3763	0.1998	0.1998	100.00
15	0.3772	0.2003	0.2003	100.00
16	0.3767	0.2000	0.1998	99.90
17	0.3777	0.2006	0.2005	99.95
18	0.3768	0.2001	0.2000	99.95

Average .. 99.94

Summary.

Series A	..	100.0
B	..	100.04
C	..	99.94
Average, 100 p. ct.		

Remarks.—0.3766 grm. microcosmic salt requires 11 c.c. of Mg mix. No. 1 for exact precipitation of the P₂O₅; 12 c.c. therefore gives an excess of 9.09 per cent. The precipitates were nearly white, and previous experiments had shown that when ignited, as in these, to constant weight over the lamp, the loss when submitted to a powerful blast was very slight. The only means at my disposal for obtaining this were a large Russian lamp combined with a clay flue.

Several of the precipitates were placed together in a plain platinum crucible after ignition over the lamp, weighed, and submitted to the blast with the following results.—

	Weight of Precipitates taken, in grammes.	Loss in grammes.
1	0.8247	0.0007
2	0.7734	0.0007
3	0.7812	0.0006
4	0.7626	0.0008
5	0.9954	0.0008
	4.1373	0.0036

Taking the average, we should have to allow 0.09 per cent off the average of the eighteen experiments recorded above, making the result 99.91 instead of 100. For comparative purposes in studying the influence of various reagents, it will be necessary to make this correction unless the P₂O₅ is precipitated in the presence of a considerable quantity of ammonium citrate.

No allowance has been made for the solvent action of the dilute ammonia used to wash with. The exact amount of error this would give rise to can hardly be determined by work done with a salt containing water of crystallisation. This point will be referred to again further on.

In all the experiments that follow—except when otherwise stated—I used, as in the above, 200 c.c. No. 3 NH₃ to wash the precipitate. Repeated trials had shown this was amply sufficient.

Preparation of Solutions.

Making up a larger volume than 500 c.c. at a time was found not to answer for the reason already given. 7.5318 grms. of the salt were dissolved, made up to 500 c.c., and the solution weighed—weight 502.66 grms. 25 c.c. would weigh 25.133 grms, contain 0.3766 grm. microcosmic salt, and yield 0.2 grm. magnesian pyrophosphate. To avoid errors from inaccuracy in measuring and variations of temperature, the 25 c.c. taken for each estimate were weighed in the beaker covered with a small clock glass. To avoid the necessity of using a new factor for correction with every fresh solution made, the flask was not filled quite to the mark, and weighed; the water required to make up the weight to 502.66 grms. was weighed in a small beaker; the whole was then well mixed and trans-

ferred to accurately ground reagent bottles, to hold about 200 c.c. Commenced to use these solutions the day after they were made.

Test Experiments.

25 c.c. micro. solution diluted with 75 c.c. water, and precipitated with 12 c.c. Mg mix. No. 1. 10 c.c. No. 1 NH₃ added after the precipitate had settled. Washed with 200 c.c. No. 3 NH₃, and ignited over the Berzelius lamp. I shall call these test experiments. As regards the manner of adding the Mg mixture, after seeing Gladding's recommendation to deliver from a burette one drop a second with constant stirring, I always adopted this method, but as my results are not recorded in the order in which they were obtained, it will be necessary to state when the reagent was delivered from the measure (about 2 c.c. at a time, the method first adopted), and when from the burette. The tests were sometimes modified by adding the 10 c.c. No. 1 NH₃ before precipitation instead of after. This was done to make the condition as regards the ammonia the same as in the precipitation of P₂O₅ in presence of ammonium oxalate and citrate, for if ammonia in considerable quantity is not added in these cases before precipitation, the precipitate has a tendency to adhere strongly to the glass.*

Except in the case of a few experiments made on the influence of heat, the rule has generally been to make a test experiment with two others on the influence of reagents. In four series I have made two tests with one other experiment for the purpose of comparing the average results of series consisting of six experiments, each made under exactly similar conditions. The conclusion arrived at from these experiments and others is that the difference between average results so obtained will never amount to 0.1 per cent, and seldom to as much as 0.05 per cent.†

By the method adopted in working with solutions, the value of the results for purposes of comparison would not be impaired by slight inaccuracy in preparing the solution, nor by slight alteration in its strength during use, nor by slight loss of water of crystallisation in the salt.

However, considering the great care taken in preparing and preserving the solutions, and that the 500 c.c. were consumed in a week, loss of water of crystallisation is really the only point that requires consideration. However carefully preserved, the salt will lose a little during a long course of experiments made with it, and the loss will not be uniform throughout the mass.

I have studied:—

1. The influence of heat.
2. Effect of precipitating with excess of Mg mixture added gradually, and added all at once to solutions diluted as usual.
3. Effect of precipitating with excess of Mg mix. added all at once to a concentrated solution of micro. salt, and the effect of adding the reagent one drop a second contrasted with adding it 2 c.c. at a time to solutions diluted as usual.
4. Effect of precipitating with slight excess of Mg mix. added gradually to a concentrated solution of micro. salt, and the precipitation of P₂O₅ in presence of ammonium chloride in solutions diluted as usual.
5. The solvent action of NH₄Cl on the precipitate, and the effect of Mg mix. in counteracting this.
6. Effect of precipitating with neutral Mg mix. in solutions of micro. salt diluted as usual.
7. The effect of precipitating with slight excess of neutral Mg mix. added gradually to concentrated solution of micro. salt, and the precipitation of P₂O₅ in presence of ammonium sulphate with slight and larger excess of reagent.
8. Influence of ammonia.
9. Solvent action of No. 2 NH₃ on the precipitate, and of No. 3 NH₃.

* Yet there are reasons why this modification of the test is not advisable, and after a time I abandoned it.

† Except perhaps where the P₂O₅ is precipitated in presence of considerable quantities of ammonium citrate or oxalate.

10. Precipitation of P_2O_5 in presence of ammonium oxalate with slight and large excess of Mg mix., and precipitating in presence of ammonium oxalate and NH_4Cl with slight excess of reagent.
11. Solvent action of ammonium oxalate on the precipitate, and influence of Mg mix. in counteracting this.
12. Precipitation of P_2O_5 in presence of ammonium citrate with slight and large excess of Mg mix., and precipitating in presence of ammonium citrate, oxalate, and chloride with excess of reagent.
13. Solvent action of ammonium citrate on the precipitate, and the influence of Mg mix. in counteracting this.
14. Precipitation of P_2O_5 in presence of ammonium citrate, oxalate, and chloride, ferric oxide, and alumina, with large excess of Mg mix.
15. Precipitation of P_2O_5 in presence of ammonium citrate, oxalate, sulphate, and chloride; ferric oxide and alumina, with large excess of Mg mix.

The Influence of Heat.

In this instance eight test experiments were made first, and eight soon after on the influence of heat, with the same solution.

November, 1882. Series D.—Eight tests. Solution made with salt crushed and pressed in the same month. Mg mixture from measure.

Tests.

No. of Expt.	Weight of Sol. in Grammes.	$Mg_2P_2O_7$ required.	$Mg_2P_2O_7$ found.	P_2O_5 found for 100 pts.tkn.
D 19	25.150	0.2001	0.2002	100.05
20	25.168	0.2003	0.2004	100.05
21	25.145	0.2001	0.2003	100.10
22	25.132	0.2000	0.2003	100.15
23	25.146	0.2001	0.2001	100.00
24	25.149	0.2001	0.2001	100.00
25	25.135	0.2000	0.2002	100.10
26	25.159	0.2002	0.2005	100.15

Average .. 100.07

November, 1882. Series E.—Solution was heated to 80° to 90° C., the flame of the lamp made small and placed about 4 inches from the bottom of the beaker. Precipitated Mg mix. from measure; in other respects conditions as in the tests. Temperature at end of precipitation about 60° C.

In the Heat.

No. of Expt.	Weight of Sol. in Grammes.	$Mg_2P_2O_7$ required.	$Mg_2P_2O_7$ found.	P_2O_5 found for 100 pts.tkn.
E 27	25.136	0.2000	0.1998	99.90
28	25.136	0.2000	0.2000	100.00
29	25.146	0.2001	0.2000	99.95
30	25.135	0.2000	0.2000	100.00
31	25.128	0.2000	0.2001	100.05
32	25.137	0.2000	0.2001	100.05
33	25.135	0.2000	0.2002	100.10
34	25.137	0.2000	0.2007	100.35

Average .. 100.05

In future each series will consist of eighteen experiments, including tests. Three estimates were made per day, and the rule observed was to take the quantity required for the three from the same bottle. To save space, the weights of solutions and precipitates will not be given, but only the P_2O_5 obtained for 100 parts taken. The experiments were made in the order in which the results are recorded in the tables, reading horizontally. Thus, Experiments Nos. 35, 41, 47 were made together; No. 36, 42, 48 made together; and so on.

Effect of precipitating with excess of Mg. Mixture added gradually and added all at once to solutions diluted as usual.

February, 1883. Series F.—Solution from the salt crushed and pressed, November, 1882.

Six Experiments.—In each, precipitated with 33 c.c. Mg Mix. No. 1, 2 c.c. at a time from the measure. All other conditions the same as tests.

Six Experiments.—In each, precipitated with 15 c.c. Mg Mix. No. 1, added all at once. All other conditions the same as tests.

Six Tests.—Mg mixture from measure.

No. of Expt.	33 c.c. Mg Mix. No. 1 added gradually.	No. of Expt.	15 c.c. Mg Mix. No. 1 added all at once.	No. of Expt.	Tests.
F 35	100.00	F 41	100.35	F 47	100.05
36	100.15	42	100.70	48	100.10
37	100.15	43	100.15	49	100.15
38	100.15	44	100.30	50	99.95
39	100.20	45	100.30	51	100.15
40	100.25	46	100.40	52	100.20

Average 100.15

Average 100.37

Average 100.10

Effect of precipitating with excess of Mg Mixture added all at once to a concentrated solution of Micro. Salt, and the effect of adding the reagent one drop a second contrasted with adding it 2 c.c. at a time to solutions diluted as usual.

February, 1883, Series G.—Solution from the salt crushed and pressed December 10, 1882.

Six Experiments. In each, added to 25 c.c. micro. solution (without further dilution) 20 c.c. Mg Mix. No. 1 all at once. When the precipitate had settled, added 10 c.c. No. 1 NH_3 .

Six Experiments. In each, precipitated with 12 c.c. Mg Mix. No. 1, delivered from burette one drop a second. All other conditions same as tests.

Six Tests.—Mg Mixture from measure.

No. of Expt.	20 c.c. Mg Mix. to concentrated sol. all at once.	No. of Expt.	12 c.c. Mg Mix. added one drop a second.	No. of Expt.	Tests.
G 53	100.30	G 59	99.90	G 65	100.10
54	100.20	60	99.95	66	100.10
55	100.25	61	99.90	67	100.10
56	100.25	62	100.00	68	99.95
57	100.30	63	100.00	69	99.95
58	100.30	64	100.00	70	100.05

Average 100.27

Average 99.96

Average 100.04

Effect of precipitating with slight excess of Mg Mix. added gradually to a concentrated solution of Micro. Salt, and the precipitation of P_2O_5 in presence of ammonium chloride in solutions diluted as usual.

March, 1883. Series H.—Solution from the salt crushed and pressed December 10, 1882.

Six Experiments.—In each, added to 25 c.c. micro. solution (without further dilution), 12 c.c. Mg Mix. No. 1 from burette. When precipitate had settled added 10 c.c. No. 1 NH_3 .

Six Experiments.—In each, precipitated in presence of 2 grammes NH_4Cl . Mg Mix. from burette; all other conditions same as tests.

Six Tests.—Mg Mixture from burette.

No. of Expt.	12 c.c. Mg Mix., a drop a second to concn. sol.	No. of Expt.	2 grms. NH_4Cl . 12 c.c. Mg Mix.	No. of Expt.	Tests.
H 71	99.90	H 77	99.75	H 83	99.95
72	99.75	78	99.90	84	100.15
73	99.85	79	99.95	85	100.20
74	99.75	80	99.95	86	100.10
75	100.00	81	100.00	87	100.20
76	99.90	82	100.05	88	100.15

Average 99.86

Average 99.93

Average 100.12

March, 1883. Series I.—Crushed and pressed a fresh portion of the salt, and repeated experiments as in series H.

I 89	99'70	I 95	99'80	I 101	100'05
90	99'75	96	99'85	102	100'05
91	99'80	97	99'80	103	100'00
92	99'95	98	99'90	104	99'90
93	99'85	99	99'85	105	99'95
94	99'80	100	99'85	106	99'95

Average 99'81 Average 99'84 Average 99'98

The solvent action of NH_4Cl on the precipitate, and the effect of Mg Mixture in counteracting this.

July, 1883. Series J.—Solution from the salt bruised and mixed, April, 1883, Mg Mix. from burette.

Six Experiments.—In each, washed the precipitate, first with 50 c.c. No. 3 NH_3 , then with 110 c.c. of a solution composed of 100 c.c. water, 10 c.c. No. 1 NH_3 and 6 grammes NH_4Cl . Finally, washed with 150 c.c. No. 3 NH_3 . All other conditions same as tests.

Six Experiments.—In each, proceeded as above, except that to the solution containing 6 grammes NH_4Cl I added 20 c.c. Mg Mixture No. 2.

Six tests.

No. of Expt.	Washed with sol. containing 6 grammes NH_4Cl .	No. of Expt.	Washed with sol. containing 6 grammes NH_4Cl and 20 c.c. Mg Mix. No. 2.	No. of Expt.	Tests.
J 107	98'35	J 113	100'00	J 119	100'00
108	98'40	114	100'05	120	100'05
109	98'55	115	100'00	121	100'10
110	98'75	116	100'20	122	100'10
111	98'80	117	100'00	123	100'05
112	98'90	118	100'25	124	100'05

Average 98'62 Average 100'08 Average 100'06

Effect of precipitating with neutral Mg Mix. in solution of Micro. Salt diluted as usual.

April, 1883. Series K.—Solution from the salt in its original condition. Mg Mixture from burette.

Six Experiments.—In each, precipitated with 12 c.c. neutral Mg Mixture; added 10 c.c. No. 3 NH_3 very gradually. All other conditions same as tests.

Twelve tests.

No. of Expt.	Neutral Mg Mix. 12 c.c.	No. of Expt.	Tests.	No. of Expt.	Tests.
K 125	99'85	K 131	99'85	K 137	99'95
126	100'05	132	100'00	138	100'00
127	100'00	133	100'00	139	100'10
128	100'05	134	100'10	140	100'05
129	100'05	135	100'00	141	99'95
130	100'05	136	100'00	142	100'05

Average 100'01 Average 99'99 Average 100'02

The effect of precipitating with slight excess of neutral Mg Mix. added gradually to concentrated solution of Micro. Salt , and the precipitation of P_2O_5 in presence of ammonium sulphate with slight and larger excess of reagent.

May, 1883. Series L.—Solution from the salt bruised and mixed, April, 1883. Mg Mixture from burette.

Six Experiments.—In each, added to 25 c.c. micro. solution (without further dilution) 12 c.c. neutral Mg mix. Then (also from burette) 10 c.c. No. 3 NH_3 , one drop a second with constant stirring. When the precipitate had settled, added 5 c.c. No. 1 NH_3 .

Six Experiments.—In each, precipitated with 24 c.c. Mg Mix. No. 1 in presence of 0'5 $\text{gramm. ammonium sulphate}$. All other conditions same as tests.

Six Tests.

No. of Expt.	Precipitated with 12 c.c. neutral Mg Mix. in concentrated solution.	No. of Expt.	0'5 $\text{gramm. NH}_4\text{O,SO}_3$ 24 c.c. Mg Mixture.	No. of Expt.	Tests.
L 143	100'05	L 149	100'10	L 155	99'95
144	99'95	150	100'25	156	100'00
145	99'95	151	100'35	157	99'95
146	100'05	152	100'30	158	99'90
147	99'95	153	100'15	159	99'95
148	100'15	154	100'45	160	100'10

Average 100'02 Average 100'27 Average 99'98

June, 1883.—Series M.—Solution from the salt bruised and mixed, April, 1883. Mg Mix. from burette.

Six Experiments.—In each, precipitated with 15 c.c. Mg Mix. No. 1 in presence of 0'5 $\text{gramm. ammonium sulphate}$. All other conditions same as tests.

Six Experiments.—In each, precipitated with 15 c.c. Mg Mix. No. 1 in presence of 0'25 $\text{gramm. ammonium sulphate}$. All other conditions same as tests.

Six Tests.

No. of Expt.	0'5 $\text{gramm. NH}_4\text{O,SO}_3$ 15 c.c. Mg Mix.	No. of Expt.	0'25 $\text{gramm. NH}_4\text{O,SO}_3$ 15 c.c. Mg Mix.	No. of Expt.	Tests.
M 161	99'90	M 167	99'95	M 173	99'90
162	100'20	168	100'10	174	100'05
163	100'10	169	100'05	175	99'95
164	100'05	170	99'90	176	99'90
165	100'05	171	100'00	177	99'90
166	100'10	172	100'15	178	100'00

Average 100'07 Average 100'02 Average 99'95

(To be continued.)

A RECALCULATION

OF

THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.
Chief Chemist to the U.S. Geological Survey, Washington.

BORON.

THE atomic weight of this element has been determined by Berzelius and by Laurent, and calculated by Dumas from some experiments by Deville.

Berzelius† based his determination upon three concordant estimations of the percentage of water in borax. Laurent‡ made use of two similar estimations, and all five may be properly put in one series, thus:—

47'10	} Berzelius.
47'10	
47'10	
47'15	} Laurent.
47'20	

Mean 47'13 \pm 0'013

Hence B = 10'943 \pm 0'023.

Dumas's|| calculations were based on Deville's analyses of the chloride and bromide of boron, which give the ratios between AgCl and BCl_3 , and between AgBr and BBr_3 . Reducing the weighings to a common standard, 100 parts of silver chloride correspond to the quantities of boron tri-chloride given in the third column:—

* Smithsonian Miscellaneous Collections. "The Constants of Nature."

† Poggend. Annal., 8, 1. 1826.

‡ Journ. f. Prakt. Chem., 47, 415. 1849.

|| Ann. Chem. Pharm., 113, 31. 1860.

0.6763 grm.	$\text{BCl}_3 = 2.447$ grms.	AgCl	27.303
0.923	"	3.395	"
			27.187

Mean 27.245 ± 0.039

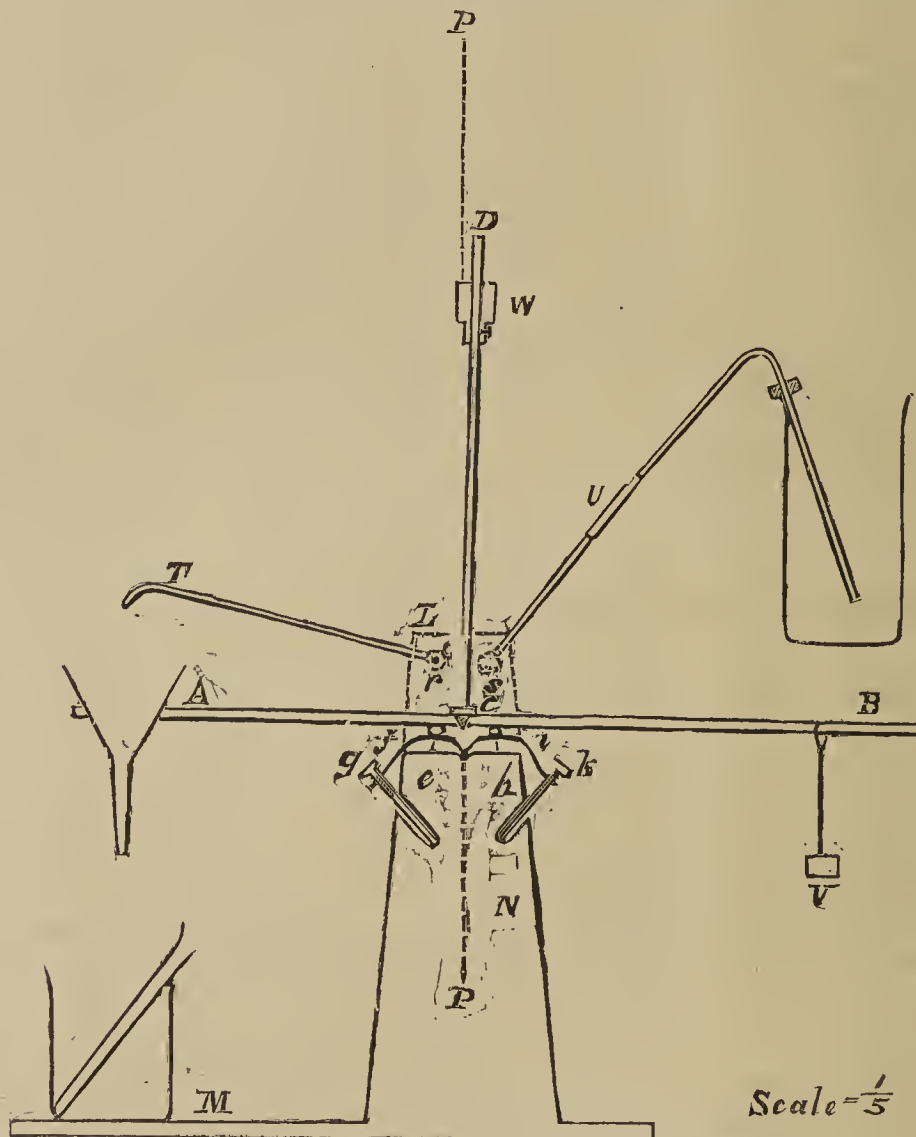
Hence $B = 10.808 \pm 0.174$.

With the bromide, 2.446 BBr_3 gave 5.496 AgBr . If we assign this experiment equal weight with one in the chloride series, and include the probable error of Br, $B = 10.964 \pm 0.364$.

FILTRATION BALANCE.

By F. P. DUNNINGTON.

ALL the arrangements for the automatic washing of precipitates, of which I have seen previous mention, provide for keeping the water at nearly a constant level in the funnel. By this method of washing a precipitate, usually much more water is necessary than if each portion is allowed to drain off before a new addition of it. At the



The three values combine as follows:—

From borax.. .. .	$B = 10.943 \pm 0.023$
From BCl_3	$B = 10.808 \pm 0.174$
From BBr_3	$B = 10.964 \pm 0.364$

General mean $B = 10.941 \pm 0.023$

If $O = 16$, $B = 10.966$.

Further investigation of the atomic weight of boron is evidently desirable.

New Method of Insulating Metallic Wires employed in Telegraphy and Telephony.—C. Wiedemann.—The author prepares a bath of potassium plumbate by dissolving 10 grms. of litharge in a litre of water to which 200 grms. caustic potassa have been added. The whole is boiled for half an hour, let settle, and decanted, when the clear liquid is ready for use. The wire to be coated is attached to the positive wire, and a small anode of platinum is plunged into the bath at the negative pole. The insulation of the wire is complete when it has taken a black-brown colour.—*Comptes Rendus*.

Cincinnati meeting of the American Association for the Advancement of Science in 1881, Prof. H. Carmichael, of Bowdoin College, Maine, exhibited a filtration and evaporation balance, which I must describe before giving my modification of it. The figure without the upright CD, illustrates this balance, which is most convenient for delivering a large amount of liquid on a small filter or into a small evaporating dish.

A beam, AB, balanced on the knife-edge (or pivot), c, supports in a ring, A, the funnel which is equipoised by the weight, v. s and r are corks passed through the upright, NL, and hold in any position the tubes U and T, which are bent to pass through them. Close to c, and under the beam, passes a rubber tube, e, which connects the tubes U and T, and conducts the wash-water or other liquid. By use of thumbscrews g and k the little brass arms f and i may be raised to adjust the pressure upon the rubber tubes e and h.

To the above-described apparatus I add a vertical rod, CD, fastened to the arm AB and at right angles to it; on this is supported a weight, w, whose height is fixed by the

binding screw also sliding on this rod. I employ for two-inch funnels a cylindrical lead weight, *v*, weighing about 300 grms.; for three-inch funnels about 500 grms. The apparatus is used as follows:—

Having brought all the precipitate on the paper in a funnel, allow it to drain, put the funnel in place and fix the weight *w* near *D*, then slide the weight *v* on *B* until it will just be able to raise *A* from its lowest position, when of course *w* will move to the right of the vertical *PP*. Then water will pass through *e* and drop into the funnel until it is nearly full, when (if *w* and *k* are adjusted properly), *A* will fall, bringing *w* to the left of the vertical, and in this position no water will pass through *e*. When the funnel has again drained, the arm *A* rises, and (the water again flows into the funnel) this alternating motion continues so long as water is supplied. I have made *AB* of iron 10 × 4 m.m. The upright *NL* is 35 m.m. thick; other dimensions may be taken from the figure. It is essential that the tube *e* admits of being closed by very gentle pressure (less than 100 grms.) of the knife-edge cut on the under side of the beam. I use for this pure rubber tubing 2.5 m.m. exterior diameter.

Removing *w* the apparatus may be used as was intended by Prof. Carmichael. When conducting an evaporation, the dish rests in *A*, and the gas passes through *h* to the burner, so that when the liquid is exhausted, and before that in the dish has come to dryness, the arm *A* will rise, compress *h*, and so extinguish the flame.—*Amer. Chem. Journ.*

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, November 1, 1883.

Dr. W. H. PERKIN, F.R.S., President, in the Chair.

THE following certificates were read for the first time:—
C. J. Baker, F. A. Blair, L. Briant, R. Datta, R. G. Durrant, T. Hart, A. E. Harris, W. Irwin, S. Johnson, R. Jackson, H. C. Lee, W. H. Martin, C. E. Potter, B. M. H. Rogers, N. G. Whittam, H. A. Wetzel.

THE PRESIDENT announced that no books would be issued from the Library during the present month, in consequence of the preparation of the Catalogue; the books can be used for reference as usual.

THE SECRETARY read the following papers:

"On the Production of Hydroxylamine from Nitric Acid," by E. DIVERS. Lossen, in 1865, prepared this substance by the action of tin and hydrochloric acid on ethyl-nitrate. Maumené showed that ammonium nitrate might be substituted for ethyl-nitrate. In 1872, the author found that sodium nitrate, and indeed nitric acid itself, could be used with excellent results. Since then the author has worked at the subject, and his results are given in the present paper. The author gives a detailed account of the action of various metals on nitric acid alone, and in the presence of hydrochloric or sulphuric acid. As an example, 58 c.c. of fuming hydrochloric acid were mixed with 5 c.c. of nitric acid (sp. gr. 1.42), and the mixture poured quickly on 35 grms. of granulated tin, placed in a flask filled with carbon dioxide. The flask was cooled by immersion in water; the ebullition soon ceased, and the solution was then poured off: 21 grms. of tin were dissolved. The solution was diluted, the tin removed by sulphuretted hydrogen, &c., and the hydroxylamine in the filtrate determined by decinormal solution of iodine, sodium carbonate being added to keep the solution alkaline. About 4½ grms. of nitric acid were thus converted (out of 5 grms.) into hydroxylamine. The following is suggested as a good lecture experiment to

show the formation of hydroxylamine. Pour some dilute sulphuric acid on zinc, and then add a little nitric acid; in half a minute pour off the acid solution, add a large excess of potassium hydrate so as to dissolve the zinc hydrate, and then a very little copper sulphate solution. The characteristic yellow precipitate, proving the presence of hydroxylamine, will appear on stirring. The latter part of the paper contains a rather lengthy discussion on the nature of the reduction of nitric acid. The author gives the following summary of his results:—Free nitric acid yields hydroxylamine when treated with tin, zinc, cadmium, magnesium, and aluminium. In the presence of hydrochloric or sulphuric acid the quantity (with tin and zinc) may be considerable. Without a second acid only traces of hydroxylamine can be detected. There is no reason to believe that the action of the hydrochloric or sulphuric acid upon the metal is instrumental in forming hydroxylamine. The second acid serves to decompose nitrate as fast as it is produced. In this way (1) it holds the hydroxylamine in a state more stable than the nitrate; (2) it preserves the hydroxylamine from the destructive action of nitrous acid by preventing that formation of this acid which would otherwise result from the reaction between a metal yielding hydroxylamine and its own nitrate; and (3) it determines the reduction of all the nitric acid to hydroxylamine by supplying the hydrogen for reproducing it and so keeping it free to the last. Metals act upon nitric acid in one of two ways, and are accordingly divisible into two classes. One includes the metals, silver, mercury, copper, and bismuth, which form nitrite, water, and nitrate, but neither ammonia nor hydroxylamine, and do not convert their nitrate to nitrite. These metals decompose nitric acid into hydroxyl and nitroxyl, combining with these radicals to form hydroxide and nitrite, which by secondary reactions become water, nitrous acid, and metal nitrate. These metals, therefore, separate nitrogen from oxygen (hydroxyl) in decomposing nitric acid; they do not in this decomposition separate hydrogen from oxygen, just as they do not do so in any other case. The other class of metals includes tin, zinc, cadmium, magnesium, aluminium, lead, iron, and the alkali metals. These metals form ammonia and generally also hydroxylamine; they do not yield nitrite or nitrous acid with free nitric acid, but they readily form nitrite by acting on their own nitrate. They exercise two actions—one upon the nitric acid, the other upon the hydroxylamine. They act first upon seven molecules of the acid, separating, in the form of hydroxylamine, the hydrogen of six of them by forming nitrate, and leaving the seventh converted into water and hydroxylamine. This action occurs without evident break into successive stages. The second action of these metals is that in which they combine with hydroxylamine to form metal ammonium hydroxide, which decomposes with water into metal hydroxide and ammonia. Nitrites have a constitution indicated by the name nitronates, *i.e.*, they have their metal directly united to their nitrogen. They have the same radical, NO_2 , as nitrates have, these being its metal-oxyl compounds.

Prof. DEBUS, while recognising the great value of the paper as to its experimental work, could not agree with some of the theoretical conclusions. The statement that a metal attached itself directly to nitrogen in a nitrite seemed quite hypothetical.

Dr. ARMSTRONG said there was so much to be learned as to the action of nitric acid, that we were as yet hardly in a position to discuss its decompositions. There seemed to be very little doubt that pure nitric acid had no action upon silver, but that some nitrous acid was necessary to start the reaction.

"On the Chemistry of Lacquer (Part I.), a communication from the Chemical Society of Tokio, by H. YOSHIDA. Japanese Lacquer (Urushi) is the milky secretion of *Rhus vernicifera*. The tree is 9 to 12 ft. high, and resembles the ordinary waxtree. Two varieties of Urushi exist, "Ki urushi" and "Seshime urushi." The "Ki urushi,"

or raw lacquer, is the best, being the natural juice, which exudes from cuts in the stem; the "Seshime urushi" being prepared by soaking branches and twigs for some months in water. The urushi is usually coloured with lampblack, vermilion, indigo, &c. The pure urushi is a thick greyish fluid, having a characteristic sweetish odour; sp. gr. 1.0020° at 20° C. When exposed to moist air at 20° in thin layers, it rapidly darkens in colour, and dries up to a lustrous translucent varnish. Ishimatsu, on February 18, 1879, gave some account of this lacquer to the Manchester Philosophical Society, and showed that it contained a resin, a gum, water, and a small quantity of residue insoluble in ether, water, and alcohol. The author extracted urushi with alcohol, and obtained a peculiar acid, urushic acid, and a volatile poisonous substance. Urushic acid, $C_{14}H_{18}O_2$, is a pasty substance, soluble in benzene, &c., which does not dry up when exposed to moist air. The author has studied the action of bromine, strong hydrochloric acid, and nitric acid, and has prepared the copper, lead, and iron salts. The gum is identical with gum arabic. A mixture of gum and urushic acid does not harden on exposure to the air. The portion insoluble in alcohol and boiling water contains a peculiar nitrogenous substance, but it has, after boiling, no action on urushic acid. If, however, after extracting the urushi with alcohol, the residue be treated with cold water, an extract is obtained containing a diastatic matter, which effects the hardening of urushi. The author has made experiments as to the hardening of urushi in different gases. He finds that moist air and a temperature of 20° to 23° C. are the most favourable conditions. After the hardening, the urushic acid is found to be converted into a new substance, oxy-urushic acid, $C_{14}H_{18}O_3$, quite insoluble in every substance tried. This body can be formed by the action of strong chromic acid on urushic acid.

The PRESIDENT said that the mode of action of the diastase did not seem very fully explained in the paper. It was curious that the lacquer varnish dried best in moist air, the reverse being the case with the ordinary varnishes in use in this country. In some experiments which he had made with an amber varnish he had found that sunlight had a great influence in promoting the hardening of the varnish.

"On some Compounds of Phenols with Amido-bases," by G. DYSON. In a recent paper Dale and Schorlemmer came to the conclusion that aurin combines with the amido-bases, and prepared pure rosanilin phenate. The author has prepared and investigated this and several other similar compounds—*aniline phenate*, *toluidine phenate*, *naphthylamine phenate*, *aniline- β -naphthate*, *toluidine naphthate*, *rosaniline phenate*, *xylydine naphthate*, *rosaniline aurinate*, *aniline aurinate*.

"On the Alleged Decomposition of Phosphorous Anhydride by Sunlight," by R. COWPER and V. B. LEWES. In a paper read before the Southport Meeting of the British Association by the Rev. A. Irving the author states that phosphorous anhydride, prepared by passing a slow stream of dry air over molten phosphorus, decomposes when exposed to sunlight into amorphous phosphorus and phosphoric anhydride. The authors have repeated this experiment and analysed the sublimate obtained in the manner described by Irving. It consisted of 78.2 per cent of phosphoric anhydride, 4.7 per cent phosphorous anhydride, and 17 per cent of phosphorus. On exposing this white mixture to sunlight it became red, the phosphorus being converted into the amorphous variety. In another experiment the air, after passing over the melted phosphorus, bubbled through carbon disulphide. After some time the bisulphide was allowed to evaporate on blotting-paper, when enough phosphorus was left behind to give dense fumes.

Prof. DEBUS called attention to the fact that it was generally stated in text-books that phosphorous anhydride could be prepared by passing air over heated phosphorus.

The Society then adjourned to November 15.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, Monday, Nov. 5, 1883.

Sir WILLIAM SIEMENS, D.C.L., LL.D., F.R.S., Manager and Vice-President, in the Chair.

John Coles and Ludwig Mond, F.C.S., were elected Members of the Royal Institution.

Five Candidates for Membership were proposed for election.

William Miller Ord, M.D., was elected a Manager in the room of the late Mr. William Spottiswoode, P.R.S.

The presents received since the last meeting were laid on the table, and the thanks of the Members returned for the same.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, April 3rd, 1883.

H. E. ROSCOE, Ph.D., LL.D., F.R.S., &c., President, in the Chair.

THE PRESIDENT exhibited the ash of burnt diamonds, and enlarged drawings of the same.

"On the Occurrence of Caffeine in the Leaves of Tea and Coffee grown at Kew Gardens," by C. SCHORLEMMER, F.R.S.

Some time ago I wanted some information on the plants containing caffeine. This interesting compound is not only found in the seeds of *Coffea arabica*, but also in the fleshy part of the berry and in the leaves. The latter are used in Sumatra by the natives in the place of tea, and some years ago a patent was taken out for the introduction of "Coffee-tea" into this country, but it has not been successful.

Caffeine also occurs in the leaves of different species or varieties of tea; in Paraguay-tea, consisting of the leaves and small twigs of *Ilex paraguayensis*; and in Guarana or Brazilian chocolate, which is obtained from the roasted seeds of *Paullinia sorbilis*. It has further been found in Cola-nuts, the seeds of *Sterculia acuminata*, which are extensively used as a condiment by the natives of western and central tropical Africa; and likewise by the negroes in the West Indies and Brazil, by whom the tree has been introduced in these countries. It is said that they promote digestion, improve the flavour of anything eaten after them, to counteract the effects of alcohol, and even to render half putrid water drinkable. Cola-nuts contain also theobromine, which is a very interesting fact, inasmuch as this base, which was first found in *Theobroma Cacao*, belonging also to the *Sterculiaceae*, can be easily transformed into caffeine.

In collecting this information I consulted, amongst other works, "the Treasure of Botany," edited by Lindley and Moore, where I found the statement that the custom of drinking coffee originated with the Abyssinians, who cultivated the plant from time immemorial. In Arabia it was not introduced until the early part of the fifteenth century; before this time the beverage made from the leaves of the kât (*Catha edulis*) was generally used, and is still in use, possessing properties resembling those of strong green tea, only more pleasing and agreeable. The leaves are also chewed, and are said to have the effect of producing great hilarity of spirits, and such an agreeable state of wakefulness that the Arabs who chew them are able to stand sentry all night long without feeling drowsy.

As the properties of kât resemble so much those of tea, it appeared to me highly probable that they contain caffeine. My friend, Mr. H. Marshall Ward, was kind enough to apply to Professor W. T. Thistleton Dyer, F.R.S., who supplied me in the beginning of December with fresh leaves of a plant growing in the

temperate house at Kew Gardens. He also sent me a sample from the museum. He says:—"The material in our museum is not very satisfactory, but I enclose a portion of an authentic sample. The leaves are different in form from those of the living plant, but I have ascertained that in this respect they are variable."

I first examined the fresh leaves; not a trace of caffeine could be found, while its presence can be easily shown in three or four tea-leaves. The only crystalline compound which I could extract from Catha was a kind of sugar, apparently mannite. The quantity was, however, too small for identifying it.

No caffeine could be detected in the authentic sample, but it contained common salt, showing that it must have been in contact with sea-water.

As I fully expected to find caffeine and was disappointed, it occurred to me that possibly the leaves of tea and coffee grown at Kew might also not contain their characteristic principle.

Professor Dyer kindly supplied me with the fresh leaves of several varieties and species in the middle of February.

I found caffeine in green tea (*Thea viridis*) and in Assam tea (*T. assamica*).

The leaves of *Coffea arabica*, which is now fruiting in the gardens, contain it also, but much less in proportion than tea.

In *Coffea laurina* I found a trace, but none at all in the large old leaves of Liberian coffee.

Caffeine and theobromine occur only in the vegetable kingdom. They are nearly related to uric acid, guanine, and xanthine, which are products of the material exchanges of the animal organism. The two former can be converted into xanthine, and this, as Professor E. Fischer has shown, into theobromine or methylxanthine, and into caffeine or dimethylxanthine.

As caffeine is used in medicine, it appears very probable that in no distant time it will be manufactured from Peruvian guano, which is the best source for guanine.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvi., No. 16, October 15, 1883.

Report on a Memoir by M. Raoult entitled—"General Law of the Solidification of Solvents."—The principal conclusions of M. Raoult's investigation are:—Every body, solid, liquid, or gaseous, when dissolving in a definite liquid compound capable of solidification, lowers its point of congelation. Of two specimens of any body the purest is that which solidifies or melts at the highest temperature. The atomic, or molecular, lowering is sensibly constant for each solvent. For most organic compounds soluble in acetic acid without alteration, it varies from 36 to 41, the mean being 39. For formic acid the mean lowering is 29; for benzol, 50; for nitro-benzol, 73; and for ethylene bibromide, 119. M. Raoult proposes the following general law:—If we search for the atomic lowering produced, not in one and the same weight of the solvent, but in weights of each solvent proportional to its atomic weight, equal, *e.g.*, to 100 times the atomic weight of the various liquids, we find that the lowering of the congelation is independent of the nature of the dissolved body and of the solvent.

A Means of Insulating the Thermic Radiations from the Luminous and Chemical Radiations.—F. van Assche.—Upon a slip of glass, the *port-object*, is deposited a drop of distilled and melted selenium, which is immediately covered with a slip of thin glass. The drop

is then compressed by means of a needle, keeping the slip upon a metallic plate at 250°, so as to spread out the selenium in a very thin homogeneous layer. Finally the arrangement is let cool very slowly under pressure. The selenium must not be allowed to boil upon the plate. By this stratum the chemical rays are reflected, the luminous vibrations are converted into electric energy, whilst the thermic waves alone traverse the plate after having undergone a certain refraction, which is rotatory if the plate turns in its own plane, but fixed if the apparatus is immovable.

Refraction Indices of Fluor Spar for Rays of Different Wave-lengths up to the Extreme Ultra-Violet.—Ed. Sarasin.—The author's results are given in a table, which space does not allow us to reproduce.

Determination of the Equivalents of Metals by Means of their Sulphates.—H. Baubigny.—This paper will be inserted in full.

Occlusion of Glucose by a Plumbic Precipitate.—P. Lagrange.—To determine exactly the glucose in a cane-sugar the method of precipitation with basic lead acetate must be abandoned.

The Guano of Cape Verd.—This guano contains merely 0.28 per cent of organic nitrogen, 0.04 ammoniacal nitrogen, and 11.37 of phosphoric acid. On the other hand, the percentage of silica and silicates is 41.06.

Bulletin de la Société Chimique de Paris.

Nos. 6 and 7, October 5, 1883.

Combustion-heat of certain Coals and their Use for heating Steam-boilers.—M. Scheurer-Kestner.—A reply to the objections raised by M. Bunte and M. Stohmann against the former results of the author and of M. Dollfus.

Formation-heat of Potassium Fluorides.—M. Guntz.—The formation-heats of the anhydrous fluoride are respectively 30.98 and 38.22 cal., according as we set out from the liquid or the gaseous acid. The formation-heat of the hydrated fluoride, setting out from the gaseous acid = 41.45 cal. That of the hydrofluoride of potassium fluoride = 53.13 cal.

Preparation of Mesitylene.—Eugene Varenne.—The author mixes 180 grms. acetone with 300 grms. sulphuric acid, leaving them in contact for an hour. He then distils over a Bunsen burner with the flame very low. The Bunsen should have a very large rose so that all the lower part of the flask may be heated uniformly. Towards the end, when the mass is on the point of swelling up, a jet of steam is allowed to bubble through it, lowering the flame or extinguishing it entirely. The steam is passed through until striæ of mesitylene cease being formed on the sides of the refrigerating tube.

Determination of Total Nitrogen in Manures.—E. Dreyfus.—The author remarks that a manure may contain nitrogen in the organic form, soluble or insoluble, as ammonia, and in the nitric form. He criticises the method of Ruffe, which he finds inaccurate, and proposes the following process:—The manure is intimately mixed, and a portion weighing 1 grm. is taken, and placed in a small glass capsule, adding pure sulphuric acid of full strength, so as to saturate the manure, and heating the whole over a Bunsen burner. The sulphuric acid expels the nitric acid and dissolves the organic matter. When the solution is complete and the sulphuric acid begins to give off vapours, the heat is withdrawn. By this operation the manure is freed from every trace of nitric nitrogen, and there remain merely the totality of the organic nitrogen and of the ammoniacal nitrogen. When the capsule is cold finely-ground calcium carbonate is added until the resulting grey mass is absolutely dry and pulverulent. The whole is carefully detached from the glass and mixed with soda-lime for the determination of the organic and the ammoniacal nitrogen. The nitric nitrogen is then

determined in a second portion by Schloësing's method. For preparing soda-lime, the author dissolves $1\frac{1}{2}$ parts caustic soda in 3 parts of water, and adds the solution to 3 parts of quicklime. To destroy any nitrates present as impurity in the soda M. Delarge dissolves a quantity of pure sugar in the soda-lye used for slacking the lime.

Anderson's Reaction.—Æchsner de Coninck.—Anderson's reaction is characteristic of the pyridic bases; it differentiates the pyridic from the quinoleic chloroplatinates; it establishes a clear distinction between the bases of the two pyridic and quinoleic series and their hydrides, and furnishes valuable indications in the study of the isomerism of these bases and of their derivatives.

Reaction of the Pyridic Bases with the Alcoholic Iodides.—Æchsner de Coninck.—This paper is not adapted for abstraction.

Biedermann's Central-Blatt für Agrikultur-Chemie,
Vol. xii., Part 9.

The Radiation of the Earth.—J. Tyndall.—From *Nature*.

Presence of Nitric Acid of Ammonia in the Water and Snow of the Alpine Glaciers.—M. Boussingault.—From the *Comptes Rendus*.

Micro-organisms in the Soil.—R. Koch and P. Miquel.—Both observers found the superficial layers of the soil exceedingly rich in bacilli. Miquel considers that these bacilli play an important part in the decomposition of organic matter and in the formation of assimilable plant food.

Aves-Guano.—Prof. Mærcker and Prof. Heiden.—This guano, obtained from certain small islands on the coast of Venezuela, contains 33 per cent of phosphoric acid, but only 0.21 nitrogen. It contains very little iron and alumina, and is, therefore, well adapted for the manufacture of superphosphate.

The Value of Various Forms of Nitrogenous Compounds for the Growth of Plants.—Prof. Mærcker.—The best result, apparently on oats, was obtained with soda-saltpetre. Ammonium sulphate was somewhat inferior, and the yield of grain weaker. Horn-meal and blood-meal delayed the harvest fourteen days, the maturity of the crop being unequal. Ground leather, fermented or unfermented, gave a crop little better than where no nitrogenous manure was applied.

Reports on Fraudulent Manures.—Dr. Stutzer, Prof. Reichardt, and Prof. Emmerling.—An account of the composition of various chemical manures, offered at prices far exceeding their value. A "Silicic Poudrette," sold at £6 per ton, contains:—Total phosphoric acid, 0.2; nitrogen, 0.3; potassa, 0.15; and, on the other hand, sand and clay, 82.8 per cent; and silica, soluble in alkali, 11.05. A special beet manure, sold at £1 2s. per kilo. (!), is applied by dissolving 4, or in case of poor soils, 5 grms. (*sic*) in 10 litres water, and sprinkling the field.

The Application of Soda Saltpetre and Ammonium Sulphate in the Cultivation of the Beet.—O. P. Dehérain.—The author's experiments would seem to prove that sulphate of ammonia has a distinctly injurious action—a result which stands in need of explanation.

Experiments on the Continuous Cultivation of Wheat and Barley at Woburn.—Dr. A. Voelcker.—From the *Journal of the Royal Agricultural Society*.

Stassfurt Salts for Sprinkling in Stables.—Prof. Mærcker.—All the Stassfurt salts prevent the volatilisation of ammonia and the escape of free nitrogen. Those which contain large proportions of magnesium chloride are not to be recommended, as they deliquesce and bring on inflammation in the feet of horses, &c. Kainite, or krugite, is therefore to be recommended.

Action of Amido Compounds on Animal Nutrition.—N. Zuntz.—Asparagin decreases the decomposition of

albumen in the system; tyrosine, taurine, and guanidine sulphocyanide have a contrary effect.

The Physiological Action of Copper upon the Organism of Domestic Ruminants.—MM. Ellenberger and Hofmeister.—The statements of Galippe, Burq, and Decom, that copper in small doses, *i.e.*, such as do not produce violent local action, is comparatively harmless, do not hold good as regards the ruminants. The elimination of copper takes place chiefly by way of the gall. It is principally deposited in the liver and the pancreas.

Sunflower Cake as Food for Milch Cows.—Dr. Schrodtt and H. v. Peter.—The total production of milk was found to be reduced by the consumption of sunflower seed cake.

Observations on Splenic Fever and Protective Inoculation.—MM. Müller, Archangelski, and Feltz.—From July 1, 1882, to May 14, 1883, there have died at Packisch, 2.41 per cent inoculated cows, 1.50 per cent inoculated sheep, and 4.65 per cent non-inoculated sheep. Of 31 cattle inoculated at Gorsleben there have died of splenic fever 9.68 per cent from August 14, 1882, to June 1, 1883. A bull which had recovered from a slight fever, was attacked again in March, 1883, and died.

Journal für Praktische Chemie.

New Series, Vol. xxviii., Parts 5 and 6, 1883.

The Products of the Dry Distillation of Para-oxybenzoic Acid.—A. Klepl.—When para-oxybenzoic acid is distilled, the half of it only is resolved into phenol and carbonic acid. The principal products are, with elimination of water, para-oxy-benzoyl-para-oxybenzoic acids, and finally para-oxy-benzide. A small quantity of para-oxybenzoic phenyl-ether is formed. Para-oxy-benzide, when submitted to dry distillation, yields phenyl-para-oxybenzoic phenyl-ether, from which phenyl-para-oxybenzoic acid is readily obtained. Para-oxybenzoic and oxybenzoic acids can be easily converted into sulphonic acids by means of sulphuric acid. The sulphones may then be directly converted into very sparingly soluble acid potassium salts, and separated from the sulphuric acid.

Synthesis of Lecithine.—F. Hundeshagen.—The author's object was to ascertain whether lecithine is a salt or an ethereal compound of an acid with an alcohol base. He has obtained an isomer of lecithine, acid næurine distearyl-glycerin-phosphate.

Physical Chemistry of the Blood.—G. Hüfner and R. Zülz. The object of the authors is to find a method for the quantitative determination of the hæmoglobine, which, on shaking up dilute solutions of this colouring-matter with atmospheric air containing variable proportions of carbon monoxide, enters into combination with the latter gas. The paper is accompanied by an illustration showing the apparatus made use of.

Pyridine in Commercial Ammonia.—H. Ost.—For the detection of this impurity the author neutralises partially with hydrochloric acid, when the pyridine is revealed by its odour. The liquid thus imperfectly neutralised may be distilled, the distillate received in hydrochloric acid, evaporated to dryness, and the alcoholic extract, after expulsion of the alcohol, precipitated with platinum chloride. After the platinum-ammonium compound has been removed the double pyridine compound crystallises out in smooth ramifying orange-red anhydrous prisms.

Journal de Pharmacie et de Chemie.

Tome viii., October, 1883.

Toxic Action and the Therapeutic Use of Potassium Dichromate (Concluded).—M. Vulpian.—A purely medical memoir.

Note on Styra.—A. Ferrand.—A pharmacographical paper.

Observations on the Action of Glycerin on certain Ethereal Solutions.—C. Méhu.—In analytical researches the presence of glycerin may prove an obstacle to the extraction of certain products by ether.

Nitro-Derivatives of Ethylene Hydride.—A. Villiers.

Memoir on Flour.—M. Balland.—Already noticed.

Volumetric Determination of Carbon Disulphide in the Sulphocarbonates.—E. Falières.

Substitution of Verdigris.—N. Gille.—A neutral copper acetate is at present sold as sub-acetate. It is a greenish blue crystalline powder, of an immediately harsh metallic flavour, and effloresces in dry air. It is entirely soluble in water.

Ichthyol.—This compound is now obtained by the distillation of a bituminous mineral found at Seefeld in Tyrol, and rich in fossil fishes.

Waters contaminated by the Drainage of Cess-pools.—M. Balland.—Into a tube 60 to 80 centimetres in length and 15 millimetres in width, and closed at one end, the author pours a few c.c. of a solution of sodium hypobromite. He fills it up completely with the water to be examined, applies the thumb to the surface so as not to admit any air, inverts the tube, and places it in a large glass containing mercury. If urea is present small bubbles of nitrogen gradually rise in the tube, and collect at the upper (closed) end.

MISCELLANEOUS.

Society of Arts.—The 130th Session of the Society of Arts will commence on the 21st inst., with an opening address from Sir William Siemens, the Chairman of the Society's Council. Previous to Christmas there will be four ordinary meetings, in addition to the opening meeting, and for these the following arrangements have been made:—November 28th, A. J. R. Trendell, "The International Fisheries Exhibition of 1883;" December 5th, Thomas T. P. Bruce Warren, "The Manufacture of Mineral Waters;" December 12th, Thomas Fletcher, F.C.S., "Coal-gas as a Labour-saving Agent in Mechanical Trades;" December 19th, W. H. Preece, F.R.S., "The Progress of Electric Lighting." There will be six courses of lectures delivered during the Session, under the bequest of Dr. Cantor. These will be—1st, "The Scientific Basis of Cookery," by W. Mattieu Williams, F.C.S.; 2nd, "Recent Improvements in Photo-Mechanical Printing Methods," by Thomas Bolas, F.C.S.; 3rd, "London Houses," by Robert W. Edis, F.S.A.; 4th, "The Alloys used for Coinage," by Professor W. Chandler Roberts, F.R.S., Chemist of the Royal Mint; 5th, "Some New Optical Instruments and Arrangements," by J. Norman Lockyer, F.R.S., F.R.A.S.; and 6th, "Fermentation and Distillation," by Professor W. Noel Hartley, F.C.S. The usual short course of Juvenile Lectures will be delivered during the Christmas holidays. The subject will be "Crystals and Crystallisation," and the lecturer Mr. J. M. Thomson, of King's College, London.

Liquid for Determining the Specific Gravity of Minerals.—Nearly all natural minerals are heavier than water, and therefore sink in it. But when they are placed in a heavy liquid which does not dissolve them, some sink and others float. If two minerals of unlike gravity occur in the same rock, they can be separated by pulverising the rock and putting them in a liquid intermediate in weight between both. A new liquid for this purpose has been devised by C. Rohrbach, having a density of 3.57. It is an iodide of barium and mercury, and is prepared as follows:—100 parts of iodide of barium and about 130 parts of red iodide of mercury are mixed with about 20 c.c. of distilled water, shaken, and heated on an oil-bath to 150° or 200° C, until dissolved, and then concentrated until it will float a crystal of topaz. After

standing several days the clear liquid is decanted and filtered. It has a yellow colour, boils at 145° C., and refracts light strongly. It can be used for separating axinite, kyanite, in part, epidote, heavy mica, some garnets, and nearly all hornblendes; also jade, olivine, orthite, nearly all members of the pyroxene group, saussurite, titanite, topaz, heavy tourmaline, vesuvianite, and basaltic rocks. In diluting it to obtain any special density, it is mixed with a dilute solution of the same, so as to avoid precipitation. After the separation the powdered minerals are washed with a few drops of iodide of potassium.—*Wiedermann's Annalen.*

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Detection of Traces of Gold.—(Reply to J. C.)—Sonstadt, *CHEMICAL NEWS*, vol. xxvi., p. 159; particularly footnote to second column, page 160.—W. H. DARLING.

MEETINGS FOR THE WEEK

SATURDAY, 10th.—Physical, 3, "Some Experiments on the Velocity of Sound in Air," by J. Blaikley. "On the Moment of a Compound Magnet," by R. H. M. Bosarquet. "On Measurements relating to the Electric Resistance of the Skin, and to certain Medico-electric Appliances," by W. L. Carpenter.
THURSDAY, 15th.—Chemical, 8. "On the Estimation of Starch," by C. O'Sullivan. "On the Products of Decomposition of Solutions of Ammonium Nitrite by Heat," by G. Stillingfleet Johnson.

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THE CHEMICAL NEWS.

VOL. XLVIII. No. 1251.

A NEW RESIDUAL PRODUCT FROM THE DISTILLATION OF COAL.

By GEORGE E. DAVIS.

THE distillation of coal, or rather, as it is generally termed, its carbonisation, is scarcely a century old, and from the very first days of the industry up to the present, nearly the sole aim has been the production of illuminating gas, the tar and the ammoniacal liquor being termed residual products. From time to time there have been proposals to turn the gas into a residual and go in for making tar-water only, and by increasing the yields of these, and by utilising the gas under the retorts, to manufacture sulphate of ammonia and tar products simply. For some reason or another these projected schemes have never been successful, for the simple reason that tar distilled from coal at a low temperature is not as good as ordinary tar, and with low temperatures the yield of ammonia water is not usually so great as with higher heats. It is true that a considerable revenue may be derived from the sale of coke, but taking all things into consideration there has been so slight a margin, except in special situations, such as distillation on the pit-bank, that but few capitalists have been induced to embark in the undertakings.

The older analyses of coal-gas gave us a very poor insight into its real composition. Bunsen in his "Gasometry," gave us elaborate methods and calculations respecting the analysis of coal-gas, but recent experiences have shown that many of the deductions are not worth the paper they are printed on. The real and most important illuminating constituents of ordinary coal-gas were entirely overlooked, and so many a practical worker was misled.

Our smoke and fog question, which has cropped up annually, has brought before our notice the gradually advancing use of gas for heating and cooking purposes, and it is evident that the gas for such purposes need not depend for its excellence upon its illuminating power. In fact its power to deposit carbon during combustion is a defect both for cooking and heating, and the use of a gas deprived of its more condensable hydrocarbon vapours would offer many advantages over the old system.

Now reference to the published analyses of coal-gas would, in most cases, lead us to believe that such a task would be impracticable as a manufacturing operation. We are told that the greater portion of the illuminants were olefiant gas, ditethyl, &c., or liquids of such low boiling-point as to be reckoned practically with the permanent gases. Investigations extending over a lengthened period have shown me that all the previous analyses of coal-gas are of no value and are moreover inaccurate. The chief illuminants are vapours of easily condensable hydrocarbons commencing to boil at below 18° C., and containing many hydrocarbons, even up to solid naphthalene. Now these "illuminants" are easily absorbed by olive oil or rape oil and even by hydrocarbon oils, and it has been found by many experiments that as much as five gallons of these condensed hydrocarbons can be obtained from the gas yielded by one ton of coal.

These hydrocarbons are worth much more than the original coal, plus materials and labour; therefore it seems a very profitable undertaking when the gas is required for cooking and heating purposes, first to extract the illuminating hydrocarbons. This can be done so completely that the gas on combustion yields only a flame of exceedingly fable luminosity, this being due to the small quantity of what we may call permanent gases still remaining.

It is clear, then, that in the treatment of coal for heating

purposes we have another residual product, if the process is so conducted as to eliminate the illuminating vapours. I propose to call it *crude benzol* in contradistinction to the *crude naphtha*, or first runnings of coal-tar.

Many of you will be aware that a process of carbonisation for the sake of these products is now most successfully carried on in the Midlands, and the process has a great future before it; but I have learned by experience that it is only those who can carry on their processes in an exact and scientific manner, and who can obtain the most from their raw material, who are likely to succeed to the end. The differences of temperature, both in retorts and out of them, lead to such variation in the quality of the crude benzol produced as to clearly point to the fact that these operations must be more carefully attended to than in ordinary gas-making.

Ordinary gas coal of good quality should yield over four gallons of this residual product, and it is very probable that before long a large quantity of it will be sent into the market. Buyers should, however, be cautious; if the heat is too low, more paraffins are formed, and this is only to be discovered by special tests. The ordinary process of distillation and catching all that which distils over at certain mean temperatures is inadequate to discover the presence of paraffins. These are, however, proved by the short yield of aniline oil produced from the benzol in question.

My object in making these few remarks is owing to having heard that carbonising is a failure, which statement can only have been made by those unacquainted with what is really going on. I am sorry I cannot go more fully into details concerning my own process, but as I intend reading an exhaustive paper at a future date upon the subject, you will soon be able to read it in the admirable journal of our Society.

CLERGET'S METHOD OF SUGAR ANALYSIS BY INVERSION.

By ALFRED J. KING.

PERHAPS the clearest exposition of the *rationale* of the above process is given by Casamajor in the *CHEMICAL NEWS*, vol. xlv., p. 148. He there points out that if we have a sugar containing:—

- | | |
|-----------------------------------|---|
| (1) Cane-sugar | C |
| (2) Invert-sugar | I |
| (3) Other right rotating bodies | G |
| (4) Other left rotating bodies .. | H |
| (5) Inactive bodies | |

and if the direct test in the optical saccharimeter gives a deviation D , then $D = C - I + G - H$, in which equation the only known quantity is D , and we want to find C . Further, by the action of the acid, C disappears, and is replaced by a quantity, i , representing the left rotation of the invert-sugar produced from the cane-sugar originally present: hence if the values, $-I + G - H$, remain constant, and D' be the reading after inversion, we have now—

$$D' = -i - I + G - H,$$

and, assuming the truth of these two equations, the value of C is easily found to be—

$$C = \frac{100(C+i)}{144 - \frac{t}{2}}$$

As Casamajor correctly states, this equation does not hold good unless the values of $-I + G - H$ are constant in the two preceding equations, but the point to which I wish to draw attention is this, that I think that not only he but most other writers have overlooked one important condition of such a constancy. It is usually assumed that these values must remain unaltered unless the acid used for inversion has some specific action upon the rotatory power of the substances whose rotations they repre-

sent. With regard to +G and -H this is probably true, but with regard to -I there is one other condition which must be attended to. Now -I represents the left-handed rotation due to invert-sugar, and the rotatory power of invert-sugar varies with the temperature. Hence, in order that -I shall be the same in both equations, the temperature of the solution at the time of reading must be the same before and after inversion. This seems so self-evident a proposition that I should not have thought it worth calling attention to, but that I find no reference to it in any account of Clerget's process that I can get hold of. Very particular instructions are given to note the exact temperature of the solution after inversion, but nothing is said as to the temperature at which the direct reading is made. Doubtless, in most cases of raw sugars and natural syrups where the percentage of invert-sugar originally present is but small, the error that might arise from neglect of this precaution could not be great; but the case is quite different with a syrup which contains from 20 to 30 per cent of invert-sugar. The overlooking of this point by those who have used the Clerget process may be the cause of the unfavourable opinion expressed of it by certain authors.

ON THE ESTIMATION OF PHOSPHORIC ACID AS MAGNESIC PYROPHOSPHATE,

AND THE INFLUENCE OF CERTAIN REAGENTS EMPLOYED IN SEPARATING THE ACID FROM BASES.

By DAVID LINDO.

(Continued from p. 221).

INFLUENCE OF AMMONIA.

April, 1883. Series N.—Solution from the salt crushed and pressed, December, 1882. Mg Mix. from burette.

Six Experiments.—In each, added the 10 c.c. No. 1 NH_3 before precipitating. All other conditions same as tests.

Twelve tests. Ammonia added after precipitation as usual.

No. of Expt.	NH_3 before precipitating.	No. of Expt.	Tests.	No. of Expt.	Tests.
N 179	100'10	N 185	100'05	N 191	100'20
180	99'90	186	100'10	192	100'20
181	100'20	187	100'20	193	100'20
182	100'20	188	100'25	194	100'20
183	100'15	189	100'20	195	100'05
184	100'15	190	100'20	196	100'20

Average 100'12 Average 100'17 Average 100'18

April, 1883. Series O.—Solution from the salt crushed only December, 1882. Mg Mixture from burette.

Six Experiments.—In each, added to the 25 c.c. solution micro. salt 55 c.c. water and 10 c.c. No. 1 NH_3 . Precipitated. When the precipitate had settled, added 20 c.c. No. 1 NH_3 . Other conditions same as tests.

Twelve tests. As usual.

No. of Expt.	10 c.c. No. 1 NH_3 before precipitating.	No. of Expt.	Tests.	No. of Expt.	Tests.
O 197	99'95	O 203	100'05	O 209	100'00
198	100'00	204	100'05	210	99'95
199	100'00	205	100'10	211	100'20
200	100'10	206	100'20	212	100'20
201	100'00	207	100'10	213	100'20
202	100'15	208	100'20	214	100'20

Average 100'03 Average 100'12 Average 100'13

April, 1883. Series P.—Solution from the salt in its original condition. Mg Mixture from burette.

Six Experiments.—In each, added to the 25 c.c. solution micro. salt, 85 c.c. ammonia water containing 11'54 per cent NH_3 . Precipitated with 12 c.c. Mg Mix. No. 1.

Twelve tests.—As usual.

No. of Expt.	Precipitated in presence of much Ammonia.	No. of Expt.	Tests.	No. of Expt.	Tests.
P 215	99'55	P 221	100'05	P 227	100'00
216	99'60	222	100'05	228	100'00
217	99'75	223	100'05	229	100'00
218	99'70	224	100'00	230	100'25
219	99'60	225	99'95	231	100'20
220	99'60	226	100'05	232	99'90

Average 99'63 Average 100'03 Average 100'06

When the P_2O_5 is precipitated in presence of much NH_3 the precipitate is very voluminous and tedious to wash. As the dilute ammonia would lose strength during the protracted washing, I washed Nos. 217, 218, 219, and 220 each with 200 c.c. No. 2 NH_3 , and protected from the air as much as possible. Nos. 215 and 216 were each washed with 200 c.c. No. 3 NH_3 , as of course were all the tests.

Solvent Action of No. 2 NH_3 on the Precipitate.*

May, 1883. Series Q.—Solution from the salt bruised and mixed, April, 1883. Mg Mixture from burette. Eighteen experiments were made, but as one of the first three was lost I rejected the other two.

Five Experiments.—In each, washed the precipitate with 200 c.c. No. 2 NH_3 . Other conditions same as tests.

Five Experiments.—In each, washed the precipitate with 600 c.c. No. 2 NH_3 . Other conditions same as tests.

Five Tests, Washed as usual with No. 3 NH_3 .

No. of Expt.	Washed with 200 c.c. No. 2 NH_3 .	No. of Expt.	Washed with 600 c.c. No. 2 NH_3 .	No. of Expt.	Tests.
Q 233	100'10	Q 238	99'55	Q 243	99'90
234	99'85	239	99'55	244	99'90
235	100'05	240	99'65	245	100'05
236	100'15	241	99'60	246	100'00
237	100'05	242	99'75	247	100'00

Average 100'04 Average 99'62 Average 99'97

May, 1883.—Series R.—Solution from the salt bruised and mixed, April, 1883. Mg Mix. from burette. Repeated eighteen experiments as above.

No. of Expt.	Washed with 200 c.c. No. 2 NH_3 .	No. of Expt.	Washed with 600 c.c. No. 2 NH_3 .	No. of Expt.	Tests.
R 248	99'95	R 254	99'50	R 260	100'05
249	100'00	255	99'55	261	100'00
250	99'95	256	99'65	262	99'85
251	100'10	257	99'75	263	99'95
252	100'05	258	99'60	264	100'00
253	100'15	259	99'70	265	100'05

Average 100'03 Average 99'62 Average 99'98

Precipitation of P_2O_5 in presence of ammonium oxalate and with slight and large excess of Mg. Mix., and precipitating in presence of ammonium oxalate and NH_4Cl with slight excess of reagent.

March, 1883. Series S.—Solution from the salt crushed and pressed, December, 1882. Mg Mix. from burette.

* Results of experiments on the solvent action of No. 3 NH_3 will be referred to further on.

Six Experiments.—In each, added to the 25 c.c. micro. solution 45 c.c. water, 30 c.c. No. 1 NH_3 , 1 gramme ammonium oxalate, 12 c.c. Mg Mixture No. 1.

Six Experiments.—In each, proceeded as above, except that only 0.25 gramme ammonium oxalate was employed.

Six Tests.—Modified; *i.e.*, the NH_3 added before instead of after precipitating.

No. of Expt.	1 gm. $\text{NH}_4\text{O}, \text{O}.$ 12 c.c. Mg Mix.	No. of Expt.	0.25 gm. $\text{NH}_4\text{O}, \text{O}.$ 12 c.c. Mg Mix.	No. of Expt.	Tests Modified.
S 266	99.40	S 272	99.70	S 278	100.00
267	99.25	273	99.75	279	100.00
268	99.30	274	99.80	280	100.00
269	99.20	275	99.80	281	100.00
270	99.35	276	99.75	282	100.05
271	99.35	277	99.95	283	100.20
Average 99.31		Average 99.79		Average 100.04	

March, 1883. Series T.—Solution from the salt crushed and pressed, December, 1882. Mg Mixture from burette.

Six Experiments.—In each, added to the 25 c.c. micro. solution 45 c.c. water, 30 c.c. No. 1 NH_3 , 1 gram. oxalate ammonium, 33 c.c. Mg Mixture No. 1.

Six Experiments.—In each, added to the 25 c.c. micro. solution 45 c.c. water, 30 c.c. No. 1 NH_3 , 1 gramme NH_4Cl , 1 gramme ammonium oxalate, 12 c.c. Mg Mixture No. 1.

Six Tests.—Modified.

No. of Expt.	1 gm. $\text{NH}_4\text{O}, \text{O}.$ 33 c.c. Mg Mix.	No. of Expt.	1 gm. $\text{NH}_4\text{O}, \text{O}.$ 1 gm. $\text{NH}_4\text{Cl}.$ 12 c.c. Mg Mix.	No. of Expt.	Tests Modified.
T 284	99.25	T 290	99.25	T 296	100.05
285	99.30	291	99.00	297	100.05
286	99.65	292	99.25	298	100.05
287	99.45	293	99.10	299	100.10
288	99.75	294	99.10	300	100.10
289	99.70	295	99.25	301	100.10
Average 99.52		Average 99.16		Average 100.07	

August, 1883. Series U.—Solution from the salt bruised and mixed, April, 1883.

Six Experiments.—In each, added to the 25 c.c. micro. solution 55 c.c. water, 20 c.c. No. 1 NH_3 , 0.5 gm. ammonium oxalate, 15 c.c. Mg Mixture No. 1 from burette. Let settle, then added 25 c.c. Mg Mixture No. 2 from the measure, 4 or 5 c.c. at a time, stirring well after each addition.

Six Experiments.—In each proceeded as above, except that at the end added 50 c.c. instead of 25 c.c. Mg Mixture No. 2 from the measure, about 10 c.c. at a time.

Six Tests.—Mg Mixture from burette.

No. of Expt.	0.5 gm. $\text{NH}_4\text{O}, \text{O}.$ 15 c.c. Mg Mix. No. 1.	No. of Expt.	0.5 gm. $\text{NH}_4\text{O}, \text{O}.$ 15 c.c. Mg Mix. No. 1.	No. of Expt.	Tests.
U 302	99.70	U 308	99.55	U 314	100.20
303	99.75	309	99.75	315	100.25
304	100.05	310	99.85	316	99.95
305	100.20	311	100.00	317	99.80
306	99.90	312	100.20	318	100.20
307	99.75	313	100.10	319	100.00
Average 99.89		Average 99.91		Average 100.07	

Solvent action of ammonium oxalate on the precipitate, and influence of Mg Mixture in counteracting this.

July, 1883. Series V.—Solution from the salt bruised and mixed, April, 1883. Mg Mixture from burette.

Six Experiments.—In each, washed the precipitate first with 50 c.c. No. 3 NH_3 , then with 110 c.c. of solution composed of 100 c.c. water, 1 gm. ammonium oxalate, and 10 c.c. No. 1 NH_3 . Finally, washed with 150 c.c. No. 3 NH_3 . Other conditions same as tests.

Six Experiments.—In each, proceeded as above, except that to the solution containing 1 gramme ammonium oxalate, I added 20 c.c. Mg Mixture No. 2.

Six Tests.

No. of Expt.	Washed with sol. containing 1 gm. $\text{NH}_4\text{O}, \text{O}.$	No. of Expt.	Washed with sol. con. 1 gm. $\text{NH}_4\text{O}, \text{O}.$ and 20 c.c. No. 2 Mg Mix.	No. of Expt.	Tests.
V 320	97.05	V 326	99.85	V 332	100.10
321	96.95	327	100.10	333	99.90
322	97.15	328	100.10	334	100.10
323	96.95	329	99.95	335	99.85
324	96.80	330	100.10	336	99.95
325	96.85	331	100.05	337	100.05
Average 96.96		Average 100.02		Average 99.99	

(To be continued.)

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.
Chief Chemist to the U.S. Geological Survey, Washington.

SILICON.

ALTHOUGH Berzelius† attempted to ascertain the atomic weight of silicon, first by converting pure Si into SiO_2 , and later from the analysis of BaSiF_6 , his results were not satisfactory. We need only consider the estimations of Pelouze, Schiel, and Dumas.

Pelouze,‡ experimenting upon silicon tetrachloride, employed his usual method of titration with a solution containing a known weight of silver. 100 parts of Ag gave the following equivalences of SiCl_4 :—

$$\begin{array}{r} 39.4325 \\ 39.4570 \\ \hline \end{array}$$

$$\text{Mean } 39.4447 \pm 0.0083$$

Hence $\text{Si} = 28.408$.

Essentially the same method was adopted by Dumas,§ Pure SiCl_4 was weighed in a sealed glass bulb, then decomposed by water, and titrated. The results for 100 Ag are given in the third column :—

2.899 grms. SiCl_4	=	7.3558 grms. Ag.	39.411
1.242	"	3.154	39.379
3.221	"	8.1875	39.340

$$\text{Mean } 39.377 \pm 0.014$$

Hence $\text{Si} = 28.117$.

Dumas and Pelouze's series combine as follows :—

Pelouze	.. .. .	39.4447 \pm 0.0083
Dumas	.. .. .	39.377 0.014

$$\text{General mean } 39.4265 \pm 0.0071$$

Hence $\text{SiCl}_4 = 169.810 \pm 0.034$.

Schiel,§ also studying the chloride of silicon, decomposed it by ammonia. After warming and long standing it was filtered, and in the filtrate the chlorine was estimated as

* Smithsonian Miscellaneous Collections. "The Constants of Nature."

† "Lehrbuch," 5 Aufl., 3, 1200.

‡ Comptes Rendus, 20, 1047. 1845.

§ Ann. Chem. Pharm., 113, 31. 1860.

§ Ann. Chem. Pharm., 120, 94.

AgCl. 100 parts of AgCl correspond to the quantities of SiCl₄ given in the last column:—

0.6738	grm. SiCl ₄	gave	2.277	AgCl.	29.592
1.3092	"		4.418	"	29.633

Mean 29.6125 \pm 0.0138

Hence SiCl₄ = 169.437 \pm 0.080, and Si = 27.957.

Combining the values for SiCl₄ we have this result:—

Pelouze and Dumas	.. ..	SiCl ₄	= 169.810	\pm	0.034
Schiel	.. ..	"	= 169.437		0.080

General mean .. = 169.675 0.031

Hence Si = 28.195 \pm 0.066; or, if O = 16, Si = 28.260.

It will be observed that all of these determinations rest upon the composition of SiCl₄, a compound for which it would not be easy to guarantee absolute purity. All the errors likely to occur in the determination of the atomic weight would be plus errors, so that the value deduced above is almost certainly too high.

DETERMINATION OF THE EQUIVALENTS OF METALS BY MEANS OF THEIR SULPHATES.

By H. BAUBIGNY.

If the determination of the equivalents of the metals by means of their sulphates has already been attempted several times, many of these determinations have not presented the agreement to be desired. The cause of these discrepancies lies in the difficulty often found in obtaining sulphates chemically neutral and always constant in composition. By successive crystallisations they can but rarely be completely freed from the last traces of free acid; some of them are even decomposed by water, and for expelling the excess of acid heat is necessary. But if it is too high there may be partial decomposition of the sulphates and the experiment may be vitiated by errors in the opposite direction. The employment of a method of heating by which the sulphates may be submitted indefinitely to a temperature constant and relatively high, but below that of their decomposition, is the first condition for securing to this kind of determination all the precision which it requires.

The use of the sulphur-bottle realises this condition. By numerous experiments the author has shown that, with the exception of the sulphates of gold and of the platinum group, which he has not studied, this class of salts possesses a stability so great that they may be kept for entire days at a temperature notably higher than the boiling point of sulphuric acid, and that even at this temperature of 440° certain sulphates only lose the last traces of free acid very slowly, and that there is room for employing certain artifices for accelerating the elimination of this acid.

This process constitutes a precise and exact method, since it enables us to avoid any overheating capable of producing incipient decomposition, and removes all doubt as to the state of the salt to be operated upon. The author has thus obtained without difficulty ferric sulphate as a perfectly definite salt of a rosy white.

The preparation of neutral anhydrous sulphates becomes under these conditions as rapid and perhaps even more certain than that of the chlorides which are also capable of retaining an excess of acid, or, if their hydrates are heated, of forming basic salts, unless we confine ourselves to the most laborious conditions of preparation.

When the sulphates are thus obtained, their analysis constitutes the second and last stage of the operation. If we take account of the decomposition of these salts by heat by the loss of their acid, as Boussingault demonstrated

in 1867, by operating in a furnace heated with the blow-pipe, this analysis may reach a high degree of perfection, for it is reduced to a calcination and two weighings, that of the sulphate with the boat in which it has been prepared (the tare of which is known), and that after calcination, which shows the loss of the acid and the weight of the oxide which remains, *i.e.* the proportion of the weights of the acid and the base.

This method of analysis by the dry way, which does not require any manipulation of the matter outside the boat which contains it, thus excluding all causes of error inherent in determinations by the moist way, permits of a greater precision than the processes of the latter kind. This analytical method is also of more easy execution than the determination of equivalents by the synthetic method, *i.e.* the transformation of a known weight of metal or oxide into sulphate—an operation in which there is danger of losses, as Berzelius and Stas declare in their remarks on the extreme difficulty of bringing such a synthesis to a good conclusion.

This process is defective only when the sulphates themselves are volatile with or without decomposition; as those of potassium, sodium, thallium, and mercury, or when the bases themselves are volatile at high temperatures, as baryta and strontia. The determination by the moist way, or that by synthesis, are then the only expedients possible, and in the latter case the last traces of free acid are expelled, before weighing the salt, by heating in the sulphur-stove.

As for the oxides capable of becoming oxidised in the air under the influence of heat, the way of dealing with this property is sufficiently well known.

The solution of the pure sulphate is evaporated in a platinum vessel, protected from the dust of the air, as recommended by M. Stas. Part of the salt is introduced into a tared platinum boat, which is allowed to slide into a glass tube, the open extremity of which alone projects out of the sulphur-stove. It is kept at this temperature until two consecutive weighings, made at an interval of several hours, are constant. For these weighings the sulphate is let cool, protected from the moisture of the air, by cleaning the glass tube at the moment when it is withdrawn from the stove.

The time which is required for the elimination of the excess of acid varies according to the kind of sulphates and the quantity operated upon. In general, a constant weight is reached more rapidly if the sulphate is in a pulverulent state. When this last point is reached the boat is put at the bottom of a platinum tube, which is placed in a muffle, so that the open end of the tube projects slightly from the mouth of the muffle. Heat is then gradually applied up to the temperature necessary for the total decomposition of the sulphate.

The use of the platinum tube has a double purpose: 1, to ascertain by examination of this tube if there has been any loss of spitting; 2, to withdraw the oxide, if reducible, from reducing action by permitting the access of the external air around the oxide; the internal atmosphere of a muffle heated with gas and closed having almost always a reducing action.

The author has never met with a trace of spitting in his determinations, and considers that if the temperature is raised gradually it never occurs with sulphates free from excess of acid.

The elimination of the acid is only considered as complete when the weighings, after two successive calcinations, give the same results. This does not exclude a counter-experiment by the moist way, *i.e.* the re-solution of the oxide in hydrochloric acid, and the application of a few drops of barium chloride to the diluted and heated solution.

In order to weigh the oxide the muffle is let cool down to dull redness, and at this moment the boat is rapidly withdrawn from the platinum tube and let slide into a glass case, previously heated in the sulphur-bottle. The case is closed and the boat weighed when cold.

In a future paper the author proposes to show the application of this method to copper, zinc, nickel, iron, aluminium, and chromium.—*Comptes Rendus* (Oct. 15th, 1883).

IODINE IN COD LIVER OIL.

BY EDWARD C. C. STANFORD, F.C.S.

"It is proposed to verify the statement in Garrod's 'Materia Medica' that cod liver oil contains 0.06 per cent. of iodine." See "Blue List."

If this statement were true, cod liver oil would be one of the richest sources of iodine with which we are acquainted. At present the marine algæ form the only commercial European source of iodine. The largest quantity of iodine found in the deep sea tangle or stems of *Laminaria digitata* amounts in the fresh plants to about 0.1 per cent. The quantity obtained when this plant is burned into kelp seldom reaches 0.05 per cent. The average yield from laminaria drift on the large scale is 0.025 per cent., but many thousands of tons of seaweed have been made into kelp and worked for iodine, which have not yielded more than 0.005 per cent., and some even less than this, so that we have to deal on the large scale with a material, and constantly to test samples, containing very small percentages of iodine. I mention this in connection with the process daily employed for many years in estimating small amounts of iodine in our laboratory, and which has also been employed in obtaining the results from cod liver oil to be published in this paper.

Much difference of opinion has arisen amongst former observers with regard to iodine in cod liver oil, and the statements of results are extremely conflicting, some chemists having failed to find iodine at all, others only in some specimens of this oil. Other chemists again have estimated the proportion of iodine as much higher than the quantity above indicated; and it has been assumed that this element represents an important factor in its medicinal value.

In a well known work on materia medica the editors remark that the state of combination in cod liver oil "may, perhaps, tend to develop a peculiar action of iodine and bromine, and endow them with an efficacy not otherwise attainable."

The following results have been published at various times by the authorities quoted:—

	Iodine per cent.
Dorvault found in cod liver oil	0.150
Raie found in cod liver oil	0.180
Joseph found nearly $\frac{1}{2}$ per cent.	0.487
Machenroden found	0.162 to 0.324
Grager found in light brown oil	0.0846
Dr. de Jongh found in pale oil	0.0374
" " pale brown	0.0406
" " brown	0.0295

All these are extremely high and improbable.

Mr. Mitchell Bird (*Pharm. Journ.*, [2], i., p. 546) gives results of analyses of six varieties of cod liver oil, which are much nearer what I believe to be the truth. The method and the results differ considerably from mine, although we are both agreed in the fact that we have found iodine in all the specimens examined.

The percentage results are as follows, the iodine being calculated as potassium iodide:—

	As KI.	As Iodine.
1. Cod liver oil, Norway ..	0.0021	average 0.001775
2. Cod liver oil, Norway ..	0.0018	
3. Cod liver oil, Norway ..	0.0016	
4. Cod liver oil, Norway ..	0.0016	average 0.000993
5. Cod liver oil, Newfoundl'nd ..	0.0012	
6. Cod liver oil, Newfoundl'nd ..	0.0014	

He used 5000 grs. of the oil for each experiment, and saponified with alcoholic solution of caustic potash, burned

the soap formed and dissolved out the salts; after saturating the solution with sulphuric acid and separating the potassium sulphate deposited, he employed the starch test, setting free the iodine with nitrite of potassium and sulphuric acid, and comparing the colour with standard solutions of potassium iodide. My method is different; it is a delicate process of very general application, and one that I adopted some years ago, having discarded all others in its favour. I will describe it here as applied to kelp, one of the most troublesome and various of all commercial substances to sample and test.

To ensure an accurate sample about 100 lbs. are carefully picked from a cargo of say 100 tons, and ground up. Of this 100 grains are taken to estimate the moisture, and another 100 grains to estimate the soluble matter, the potash, and the iodine. The kelp is treated with about 4 ounces of hot water, which dissolves little or none of the oxysulphides; this operation is repeated, the residue washed, and the solution made up to 5000 grains measure. Of this 1-10th part or 500 grains measure, equal to 10 grs. of kelp, is taken for estimating the iodine, so that we never operate on more than 1-10th of a grain of iodine, generally 1-20th, often 1-100th. In fact, if the amount present exceeds 1-10th of a grain, we always dilute the solution. 100 grains measure of bisulphide of carbon are added, and a few drops (1 to 3) of nitrosulphuric acid* dropped in. The testings are performed in large even tubes and compared with graduated standard solutions of potassium iodide treated in the same manner. By this method 1-250000th part is easily detected and measured, and up to 1-100000th part the estimation is very accurate. If the iodine in a seaweed or other organic substance is to be determined, it is carbonised in a small iron retort or crucible, and the charcoal treated in the same way. Burning to ash, however carefully done, involves a considerable loss of iodine, more than is generally supposed. For instance, a sample of seaweed ash exposed for twenty-four hours in an open crucible over an ordinary Bunsen burner will not retain a trace of iodine at the end of that time. We invariably carbonise the material in preference to burning to ash, in order to retain all the iodine and to easily extract the salts. Some of these specimens are extremely difficult, indeed, almost impossible, to burn to complete ash on account of the large proportion of fusible salts present. In estimating the small quantities of iodine necessary in our analyses we are really limited to colour tests. I have long discarded starch, as it introduces an organic substance very liable to change, and in many circumstances unreliable. Moreover, in my hands it is not so sensitive as that with bisulphide of carbon. The solution is not perfectly transparent, and the indications not so sharp. The colour is spread over the whole liquid, and when dilute can only be seen by looking down the length of the tube, whereas in the bisulphide of carbon test it is removed out of the solution and concentrated in a sixth of the volume at the bottom of the tube. The comparison of the two methods is very marked. In testing a solution of potassium iodide containing only 1-250000th part of iodine, the maximum effect is immediate, and another advantage is that the iodine can be easily separated from its solution in bisulphide of carbon. We usually recover the latter by treating it with zinc in the presence of water. The specimens of cod liver oil experimented on, for which I am indebted to our mutual friend and former President, Mr. Reynolds, were taken in quantities of 5000 grains each, saponified with 1000 grains of caustic soda, pure and free from iodine, then carbonised in a large porcelain crucible; the resulting charcoal was treated with hot water and made up to 5000 grains measure. One-tenth of this or 500 grains was found quite sufficient to detect the presence of iodine, and to estimate it. Three experiments were made, taking 500 grains, 2500 grains, and

* The nitrosulphuric acid is made by treating starch with nitric acid, and passing the nitrous fumes into sulphuric acid, 1.843 sp. gr., to saturation. The mixture keeps very well.

1000 grains respectively, with pretty concordant results. The mean results are appended.

In the first experiment the solution was tested at once in the manner indicated. In the second the solution was neutralised with hydrochloric acid in the presence of the carbon bisulphide, no iodine was eliminated until the nitro-sulphuric acid was added. In the third the solution was neutralised with hydrochloric acid before the addition of the test solutions. Little difference was noticed. The following six specimens were selected:—

- No. 1. Cod liver oil, pale.
- No. 2. Cod liver oil, Norway.
- No. 3. Cod liver oil, manufactured by Carr and Sons, Berwick-on-Tweed.
- No. 4. Cod liver oil, English.
- No. 5. Cod liver oil, Newfoundland.
- No. 6. Light brown cod liver oil.

The mean proportions of iodine found were per cent—

No. 1. 0.000410	} Mean percentage of iodine,	0.000322.
No. 2. 0.000434		
No. 3. 0.000276		
No. 4. 0.000138		
No. 5. 0.000315		
No. 6. 0.000360		

I also estimated the iodine in fresh cod liver; the fishmonger informed me that it was not in season, but the result is here appended. 5000 grains were treated in the same manner as the oil. Having stated on a former occasion (B. Pharm. Conference, Liverpool) that the oil vomited by the fulmar (*Fulmaris glacialis*)* of St. Kilda, and which, though obtained from a bird, has the reactions of a fish liver oil, contains iodide, I have also estimated this amount. 5000 grains were treated in the same way as the cod liver oil.

Cod liver oil dragées are stated to be made of cod liver from which the oil has been removed; an analysis of these is also appended. 1000 grains or 173 of the dragées were employed saponified and with 200 grains of caustic soda. These are extremely rich in iodine, and would form a valuable source of that element if they can be procured cheap enough to contend with the present low prices. I notice, however, that a box of 250 dragées sells at 5s., and is considered (by the maker) to be equal to 6 pints of oil, so that the quantity employed would be equal to 83 ounces or 36,312 grains, or about seven times the quantity of oil used in the other experiments. It contains one hundred and eighty-seven times the proportion of iodine.

	Per cent.
Fulmar oil contains iodine	0.000095
Cod liver fresh contains iodine	0.000817
Cod liver oil dragées contain iodine ..	0.056366†

It will be noticed that the fresh cod liver contains more than double as much iodine as the mean percentage in the oil. Mr. Gate has kindly sent me an estimate of the yield from his experience of ten years' average of oil from cod liver; it is about 45 per cent, taking the best time, December. The inference is that the liver without the oil would contain a much higher percentage of iodine, as shown, indeed, in the dry dragées. And I shall not be surprised to find as much in the fish. This point is under investigation.

Scotch herring has been said by "Jonas" to contain iodine, and this is also under investigation.

I have received the results of the analysis of fresh cod, herring, and herring brine.

5000 grains of fresh cod were treated with ..	500 grains caustic soda.
*5000 grains of salt herrings were treated with	" "
*5000 grains of herring brine were treated with	" "

* Two determinations were made, one with 500 grains and another with 4500 grains, and the mean taken.

Fresh cod fish contained 0.00016 per cent iodine dry = 0.000829.

Scotch herring salted contained 0.00065 per cent iodine. " brine " 0.00012 " "

The cod fish contained 80.7 per cent water.

In the fresh cod fish the analyst for the first time in these experiments was troubled with a large quantity of sulphides, and in this case only was not satisfied with the indication from 500 grains measure, and was obliged to use the larger quantity.

It will be seen that the herring contains four times the amount of iodine contained in the cod fish, and more than in any of the samples of cod liver oil; if, therefore, the iodine be the medicinal element, you should recommend Scotch herring salted; it is very cheap at present.

I find the subject becoming interesting, and, indeed, alarming to the iodine maker, and intend examining other varieties of fresh fish, for I expect to find iodine in all, and, if so, every man who eats fish will become his own iodine eliminator. Specimens of true genuine unmixed whale, seal, and bottlenose oil have been sent me by my friend, Captain John Gray, a celebrated Peterhead whaler, to whom the Arctic regions are a kind of "Winter Garden," and these are under examination, but I cannot yet report the results.

Since the publication of the paper, the following results have been obtained, the respective oils having been treated in the same manner as the cod liver oil:—

	Per cent.
Whale oil, cold drawn, contains iodine	0.00001
Bottlenose " " "	0.00010
Seal " " "	0.00005

—*Pharmaceutical Journal*, November, 1883.

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Saturday, November 10, 1883.

Prof. CLIFTON, President, in the Chair.

Dr. J. BLAICKLEY read a paper on the "*Velocity of Sound in Air*," in which he described a modification of Dulong's method of measuring it by the wave-length in a pipe lengthened. Dulong did not allow for the partial tones, which are an important factor, whereas Mr. Blaikley does. By means of organ pipes of different diameters the author has found the velocity to be about 320 metres per second. Mean result with four tubes:—One of 54.1 millimetres in diameter: velocity=329.73 metres per second. One of 32.5 m.m. diameter: velocity=328.78 metres. One of 19.5 m.m. diameter: velocity=326.9 metres. One of 11.7 m.m.: velocity=324.56 metres. The velocity diminishes as the tube is smaller in bore.

Mr. BOSANQUET made a communication on the moment of a compound magnet, which he showed how to measure by the method already published by him.

A compound magnet made up of 18 small cylinders of magnetised steel, placed end to end, is hung in a cradle carried by a delicate bifilar suspension, and placed at right

* *Pharmaceutical Journal*, November, 1870.

† In the published analysis of these by Professor Garreau the iodine is estimated at 0.154 per cent, i.e., richer than any other known organic substance.

angles to the magnetic meridian. The deviation from zero produced by the magnet is noted; then the magnet is divided into two parallel rows of nine cylinders along the cradle and the deviation again noted. The tangent of the angle of deviation from the east and west line multiplied by a constant is the moment of the magnet. The author also pointed out that to define the condition of a permanent magnet it was necessary to know the difference of magnetic potential, the "resistance" of the metal, and the resistance of the external space.

Mr. W. LANT CARPENTER read a paper "*On Measurements relating to the Electric Resistance of the Skin, and certain Medico Appliances.*" The author's experiments made upon himself, showed that the resistance of the body amounts to thousands of ohms, but is mainly due to the condition of the epidermis. If this is dry the resistance is high. By soaking the skin in salt and water he reduced the resistance of parts of his body from 10,300 ohms to 935 ohms, after 100 minutes' soaking. He infers that a large electrode should be used in applying electricity to the body, and that the skin should be soaked for 25 minutes previously. Mr. Carpenter also exhibited a "chain band," by Mr. Pulvermacher, and a small voltameter by the same inventor, in which the liberated gases force some of the water up a graduated tube as a gauge of the current. The author drew attention to the necessity of seeing that the skin should be dry in handling some electric light machines, else disagreeable shocks might result.

Professor AYRTON believed that the danger of electric lighting currents lay rather in their discontinuity than their electromotive force. The Brush currents, which have proved fatal, are more discontinuous than those of the Gramme machine, &c. Adverting to the presence of electricity in the air as influencing health, he suggested that the influence might be studied by electrifying the air—say in a hospital ward.

Mr. W. COFFIN stated that statically electrifying patients had been tried at Bellevue Hospital, New York, without definite results.

NOTICES OF BOOKS.

The Chemistry of the Secondary Batteries of Planté and Faure (Nature Series). By J. H. GLADSTONE, Ph.D., F.R.S., and ALFRED TRIBE, F.Inst.C. London: Macmillan and Co.

It is a matter of some difficulty to imagine for what class of readers this little manual of sixty pages has been written. Issued as one of the "Nature" series one would naturally expect the book to be somewhat like the other excellent members of this series, of an elementary character that might be of interest to persons other than those directly connected with electrical science, but, far from this being the case, the matter that is here brought together consists in substance of several communications on the chemistry of secondary batteries, addressed by the authors to the scientific world during the past and present year, with some slight verbal alterations and a few notes explanatory of the experiments.

The subject that is here discussed is certainly one of great importance at the present time as regards the right understanding of the conditions necessary for the economical utilisation of electrolytic action as a source of energy, and is consequently one to which the attention of many physicists and chemists is turned. Unlike the majority of batteries in use the chemical changes that take place in the lead and lead-peroxide cells of Planté and Faure are of a much less simple nature, and this subject, although of vital importance, has to a great extent been disregarded by practical electricians, and as yet the chemical conditions for success are vague. However, all investigations of these matters are valuable, and everyone interested in the adoption of electricity in the industries will

feel indebted to the authors for bringing together in this little book the results of their experiments on the chemical changes that occur in the so-called accumulators.

The contents are divided into four parts, the first being on local action, in which is shown the analogy between the negative plate of a Planté secondary battery and the authors' copper-zinc couple as regards its chemical behaviour. The conclusions the authors draw from their experiments on this point are that, "In the Planté or Faure battery local action necessarily takes place on the negative plate, with the production of sulphide of lead," and that "The formation of this sulphate of lead is absolutely requisite in order that the charge should be retained for a sufficient time to be practically available." Parts II. and III. treat of the chemical changes that take place in charging and discharging these batteries, the reactions that occur being expressed in symbols based on experiment. In the succeeding part the formation of plumbic sulphate on the plates is discussed, and the important point as to whether or not this compound is reduced by re-charging the cell is, the authors consider, settled by their experiments in the affirmative.

The concluding section describes their experiments on the influence of strength of acid, temperature, and some other miscellaneous factors relating to secondary batteries, and in an appendix is given some observations on the formation of plumbic sulphate on the plates.

The Patents, Designs, and Trade Marks Act, 1883. By JAMES JOHNSON, Barrister-at-law, and J. HENRY JOHNSON, Assoc. Inst. C.E. London: Longmans, Green, and Co.

ON the first of January of next year there will come into operation the new Act to amend and consolidate the law relating to Patents for Inventions, Registration of Designs and Trade Marks, which will be greeted with some satisfaction by the host of inventors who have hitherto been debarred from obtaining protection for their inventions owing to the excessively high cost that such protection has entailed. This new Act which is about to come into force has been gained only after a vast amount of agitation on the part of inventors, and it will not be long before the simplification of procedure and reduction of fees in obtaining a patent will be felt in the industries, as by this means an impetus and great encouragement will be given to inventors who, under the old regulations, might have hesitated to pay the large fees requisite to obtain reasonable protection for their ideas and plans. As the Act is printed and annotated in this little manual before us the would-be inventor has a very clear exposition of the procedure that is required to be gone through in order to obtain his patent rights, and legal points which might appear hazy are carefully explained. In one respect, however, the book is incomplete, for the preface tells us that, "The general rules which the Board of Trade is empowered by the new Act to make for regulating the business of the Patent Office, and the matter placed under the charge of the Comptroller, have not been issued at the time of the publication of this volume. As soon as they make their appearance, a new edition, embodying them, will be published."

With a short introduction giving a synopsis of the principal points in the new Act and a very full index, the book will be of considerable assistance to the inventor.

*Chemiker Kalender, 1884.** By Dr. RUDOLF BIEDERMANN. Berlin: Julius Springer.

THE gradual approach of another year calls forth the customary number of calendars such as the one before us, intended to furnish in the smallest compass facts and data of great service to the chemist. For the fifth year now this excellent little pocket-book with its *Beilage* or supplement is issued to the chemical world, and in the present

* "The Chemists' Calendar."

case several valuable additions and improvements are visible in the contents, although the general method of arranging and classifying the data is not disturbed. Some of the chapters have been revised and altered to some extent, H. Vogel having reconstructed the chapter on spectrum analysis, while H. Arzruni has revised the lengthy section on minerals. Among the numerous tables are given the usual ones for the corrections to be applied for variations of temperature and pressure in gas analysis, conversion of one thermometric scale into another; densities of the solutions of many of the more common compounds, acids, alkalies, and salts, and degrees of solubility; indeed there is scarcely one chemical industry which is not represented by some useful data of one kind or another. The supplement, to which is prefixed a short biography of the late F. Wöhler, is filled with facts and formulæ relating to mathematics, mass and weight, heat, light, and electricity, so far as these matters are connected with chemical science. As an appendix to the supplement is given a series of short notices of the principal educational institutions throughout Germany in which chemical and physical sciences may be studied, with the names of the teachers of the different branches.

CORRESPONDENCE.

YELLOW HYDROCHLORIC ACID.

SIR,—As the colour of commercial hydrochloric acid is a subject which has occupied the attention of your readers lately, the following facts may appear worthy of being added to those already communicated.

Some acid bought as "pure hydrochloric acid" was found to have a deeper tinge of yellow than usual, and to contain small traces of sulphuric acid. It was therefore distilled in order to obtain a pure product. The residue from two litres of the acid left behind in the flask measured about 300 c.c., and was of a full yellow colour. When evaporated to dryness, this yellow acid, which was free from iron, left a white residue. The white solid residue when ignited in platinum gave off acid fumes with charring, and left a considerable percentage of ash of alkaline reaction. The alkaline ash partially dissolved in acid with separation of silica.

In this case the yellow colour of the "pure" acid seems to have been due to organic matter.—I am, &c.,

THOMAS BAYLEY.

Laboratory, 7, Broad Street Corner,
Birmingham.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin.
Vol. 16, No. 4.

Microscopic Examination of Printed Calico.—R. Meyer.—The "fast" colouration of textile fibres depends on the penetration of the fibre by the colouring-matter, or the materials which produce it, in a dissolved condition, and its subsequent conversion into an insoluble body. This process can be effected either by the operations of dyeing, or as is more frequently the case in printing, by application and subsequent steaming. Among the steam colours there is a class the fixation of which depends on a quite different principle, *i.e.*, the albumen colours. Insoluble or indifferent colours are mixed with albumen, printed, and steamed. The albumen is coagulated and

thus cements the colour to the fibre. In examining printed goods the question may often arise whether the colouring-matter has been produced within the fibre or whether it has been fixed by the aid of albumen. If the swatch is macerated and teased out with a needle, so that the single fibres are separated, they appear on examination with the microscope uniformly coloured through their entire mass, and translucent if they have been steeped in dissolved tinctorial substances. In colours applied by means of albumen the fibre itself appears as perfectly colourless, but in numerous places there are found adhering coloured fragments of albumen.

Density of Chlorine at High Temperatures.—J. M. Crafts.—The author's experiments assign to chlorine, up to 1200°, and under atmospheric pressure, the normal density. This result agrees with that of Prof. V. Meyer.

Isolation of the Poisonous Matter contained in certain Lupins.—C. Arnold.—The author has extracted from lupins a shining brown solid matter, of a pleasant aromatic odour and taste. In water it dissolves slowly, forming a turbid solution. In doses of 10 grms. it produces the usual symptoms of lupinosis, especially acute jaundice.

A Trisulph-acid of β -Naphthol.—I. Levinstein.—The author, having prepared the above-mentioned compound, notices a trisulph-acid of β -naphthol, which C. F. L. Limbach has described in the *Journal of Chemical Industry* and has patented. The author suggests that we have here to do with two isomers.

A Correction.—M. Traube.—The author, referring to a former paper, where de-oxidisable has been printed instead of dys-oxidisable, proposes "brad-oxidisable" in place of the latter term.

Colouring-matters of the Saffranine Series.—R. Nietzki.—The author gives an account of pheno-saffranine, di-ethyl-saffranine, tetra-ethyl-saffranine, and of certain intermediate products of the formation of saffranine.

Phosphorescence of Sulphur.—O. Jacobsen.—The author refers to a number of works in which this phenomenon is mentioned. It was a matter of frequent observation when the old brimstone matches were in use.

Pyro-sulphuryl-chloride.—K. Heumann and P. Kœchlin.—The authors find that the vapour density is, not, as Ogier maintains, constant at half the normal figure from 160° to 442°, but that at temperatures not far above the boiling-point it has the normal density for the formula $S_2O_5Cl_2$. The reactions of pyro-sulphuryl-chloride are also stated.

New Methods of Formation of Pyro-sulphuryl-chloride and of Chloro-sulphonic Acid.—G. Billitz and K. Heumann.—The authors have obtained pyro-sulphuryl-chloride by acting on chloro-sulphuric acid with phosphorus pentoxide.

Tetric Acid.—Wladimir Pawlow.—Mono-brom-methyl-acetic ester is carefully freed from hydrogen bromide by washing with water, dried with calcium chloride, and heated to 100° in sealed tubes for five to six hours. The crystalline mass produced, when free from the mother-liquor, is tetric acid of great purity, agreeing in its properties and reactions with that of Demargay.

Synthesis of the Oxaline Bases.—Br. Radziszewski.—An extensive paper, in which the author gives an account of glyoxal-ethylene and glyoxal-propylene.

Hydroxylamine Reactions.—E. Nägeli.—The author has obtained and analysed mesityloxim, phoroxim, allyl-acetoxim, suberoxim, and camphoroxim.

Benzil.—M. Wittenberg and V. Meyer.—The author comes to the conclusion that benzil contains only one carbonyl group.

Reduction of the Tungsten Compounds.—Baron v. d. Pfordten.—This paper will be inserted at some length.

Qualitative Detection of Acetal.—M. Grodski.—If a dilute watery solution of acetal is mixed in the usual manner with normal soda and normal solution of iodine, the liquid is perfectly clear. But if the same solution is acidified with a few drops of hydrochloric acid, and if the soda-lye and solution of iodine are then added, there is formed a thick yellow precipitate of iodoform.

Conversion of the Phenoles into Nitriles and Carbon Acids.—V. Merz.—The author and Weith have formerly shown that from the mono-halogen derivatives of the benzol hydrocarbons the corresponding nitriles may be obtained by heating with the metallic cyanides. According to Scrugham, triphenyl phosphate yields, with potassium, benzo-nitril. The neutral phosphoric ethers of the phenoles can be easily obtained from the latter by the action of phosphorus oxy-chloride. The author has therefore induced R. Heim to examine the behaviour of the above-mentioned esters when heated with potassium cyanide. There were formed nitriles, which, on saponification, yielded the expected acids.

Action of Phthalic Anhydride upon Quinoline Bases.—Emil Jacobsen and C. L. Reimer.—The authors assert their priority in the investigation of the results of this reaction, but their analytical results differ somewhat from those of Traub. Their experiments prove the total difference of coal-tar quinoline from the artificial quinoline obtained on Skraup's method and from cinchonine-quinoline.

Action of Chlor-acetic Ether upon Primary Diamines.—J. Zimmermann and M. Kuyrim.—By a reaction of this kind the authors have obtained phenylen-diglycocol.

Synthesis of Dihydronaphthoe Acid.—H. von Pechmann.—The author mixes benzyl-acetacetic ester with 6 to 8 parts of concentrated sulphuric acid, which has been previously mixed with a few drops of water, and pours it, after standing for several hours, into cold water. A fine white powder is separated, which, when purified by re-crystallisation from ether, is dihydronaphthoe acid.

A Contribution to our Knowledge of the Aromatic Nitroso Compounds.—S. Gabriel.—The author has examined nitroso-indol and ortho-phenyl-nitroso-acetic ethyl.

Derivatives of Allylamine.—C. Liebermann and C. Paal.—A very voluminous memoir which does not admit of useful abstraction.

Oxalines and Glyoxalines.—O. Wallach.—An account of ethyl-glyoxaline, methyl-glyoxaline, oxal-ethyl, chloroxal-ethyl, para-methyl-glyoxaline, the corresponding ethyl compound, para-propyl-glyoxaline, and oxal-ethyl.

Meta-nitro-phenyl-thio-carbimide.—H. Steudemann.—In order to prepare a nitro derivative of phenyl-thio-carbimide, the author dissolves sulpho-urea in hot acetic anhydride, adds water, and boils for a short time, when a heavy oil sinks to the bottom, which on cooling is interspersed with numerous crystals.

Nitro Derivatives of Resorcine.—P. G. W. Typke.—The author used as his starting-point diacetyl-resorcin, and he has obtained and examined dinitro-resorcin, monobrom-dinitro-resorcin, diamido-resorcin hydrochlorate, and diimido-resorcin.

The Action of Bromine in Alkaline Solution upon the Amines.—A. W. Hofmann.—If the hydrochloric solution of a primary monamine of the aliphatic series is mixed with an alkaline solution of bromine, using, by preference, 1 mol. primary monamine, 2 mols. bromine, and a corresponding quantity of alkali, there are formed mono-alkalised nitro-bromides, containing 2 atoms of bromine.

A Convenient Preparation of the Paraffins.—B. Köhnlein.—The author proposes a method for obtaining the hydrocarbons $C_n H_{2n+2}$, the homologues of methane.

Pure anhydrous aluminium chloride was brought in contact in a tube with pure dry propyl-iodide, the liquid assumed a dark colour in the cold. After the air had been exhausted, and the tube had been heated for some hours to 130° to 140°, it was found to contain fine large crystals of iodine, a mobile liquid, and a gas, which was perfectly pure propan.

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Further Observations on Piperidine and Pyridine.—A. W. Hofmann.—Piperidine is readily converted into pyridine by means of bromine. The inverse transformation was attempted, but without success.

Behaviour of the Cyanic Compounds of the Three Isomeric Phenylen-diamines.—E. Lellmann.—The transition of phenylen-diamine-dicyanate into phenylen-diurea is the same for all the three isomers. The author gives an account of the preparation and properties of ortho-, meta-, and para-phenylen-diurea.

Nitro and Amido Derivatives of Benzol-sulph-anilide and Benzol-sulph-para-toluid.—E. Lellmann.—An account of benzol-sulph-ortho-nitranilide, the corresponding meta and para compounds, of benzol-sulph-meta-nitro-para-toluid, benzol-sulph-meta-dinitro-para-toluid, benzol-sulph-ortho-amido-anilide, and benzol-sulpho-metamido-para-toluid.

Theory of Phosphorescent Phenomena.—Br. Radziszewski.—The substances—several hundreds—which the author has examined, resolve themselves into two groups: 1. Such as become luminous on the addition of alkalies when they already contain active oxygen which is generated in them by the influence of some excitant, e.g., sunshine; and, 2, such as on the addition of alkalies generate active oxygen and phosphoresce on combining therewith. To the first group belong various hydrocarbons, the terpenes, &c. Some of these bodies emit light when exactly neutralised with milk of lime, &c. They are beautifully luminous when heated with dry caustic alkali. To the second group belong aldehyds, or bodies which produce aldehyds on treatment with alkalies. These bodies, however, are not luminous in aqueous solutions. The author enters upon the question of the activation of oxygen, especially in the living organism.

Sulphuric Acid in Sherries.—E. Borgmann.—The author has analysed vineyard soil from the best sherry districts, and finds that it contains only 0.1578 per cent of sulphuric acid,—a proportion by no means abnormally high, and quite insufficient to account for the considerable percentage of sulphuric acid found in the sherry of commerce.

The Behaviour of Sulphuryl-chloride and of Chloro-sulphonic Acid at High Temperatures.—K. Heumann and P. Kœchlin.—At 184° the vapour-density of sulphuryl-chloride is still normal, the compound having undergone neither dissociation nor decomposition. At 442° the molecule is completely broken up. The vapour-density of chloro-sulphonic acid at 184° shows dissociation; at 442° the decomposition is complete.

Constitution of Nitroso-malonic Acid.—V. Meyer and A. Müller.—This memoir does not admit of useful abstraction.

Reduction of Substituted Phenols.—F. Pfaff.—The author attempts to obtain substituted resorcins of known constitution, examining their behaviour with phthalic acid. He has examined mono-brom-meta-nitro-phenol, studied its reduction, its methyl-ether and its reduction. He has also examined meta-anisidine, the salts of mono-brom-meta-nitro-phenol, and nitroxylenol.

Oxidising Action of Dilute Nitric Acid upon Meta-isobutyl-toluol.—W. Kelbe.—The author obtains by this reaction an acid which may be regarded either as meta-isobutyl-benzoic acid or as meta-tolyl-isobutyric acid. From petroleum ether it crystallises in fine needles, fusible at 91° to 92°. The solution in ammonia yields

with silver nitrate a white precipitate, very sparingly soluble in water.

The Displacement of the Sulpho-group by Chlorine.—W. Kelbe.—The author's researches refer to the elimination of the sulpho-group from cymol sulphuric acid by means of chlorine. The product of the reaction is tetra-chlor-cymol.

The Crystalline Form and Composition of Barium-para-toluol-sulphate.—W. Kelbe.—At temperatures above 30° this salt crystallises in anhydrous leaflets, but below 30°, in needles, with 3 mols. of crystalline water.

Action of Aluminium Bromide upon Symmetric Dibrom-ethylene and Benzol.—R. Anschütz.—The principal product of the reaction is dibenzyl, accompanied by a small quantity of anthracene.

A New Synthesis of Anthracene.—R. Anschütz and F. Eltzbacher.—The authors obtain anthracene from acetylene bromide and benzol under the influence of aluminium chloride.

Action of Zinc Chloride upon Camphor.—A. Reuter.—Not suitable for abstraction.

A Transposition by Means of the Anhydro-compound.—W. Böttcher.—The compound formed by anhydro-benzamido-phenol on taking up water is Hübner's benzamido-phenol.

Salt-formation of Symmetric Tribrom-aniline.—L. Gattermann.—The author has produced and examined symmetrical tribrom-aniline hydrobromate and hydrochlorate.

Action of Acetyl-chloride upon Benzaldehyd in Presence of Zinc Powder.—C. Paal.—An examination of the compound $C_9H_8O_2$, which the author had formerly obtained.

Derivatives of α -Naphthoeic Acid.—P. Bössneck.—The author gives an account of the transformation of naphthoyl-chloride into α -naphthoyl-cyanide, of naphthoyl-formic acid, naphthyl-acetic acid, α -naphthyl-acetamide, α -naphthyl-aceto-nitril, and α -naphthyl ethenyl-diphenyl-diamine.

The Oxidation of Piperidine.—C. Schotten.—The author describes the preparation and properties of piperidic acid, nitro-dehydro-piperyl-urethan, the brom-hydroxyl derivative of the last-mentioned compound, piperyl-methyl-urethan, nitro-dehydro-piperyl-methyl-urethan, and the action of bromine upon piperyl-ethyl-urethan.

Triacetone-alkamine.—E. Fischer.—The author, with the view of testing the accuracy of the formula proposed by Heintz, endeavours to convert triacetone-alkamine by the abscission of water into an anoxxygenous base of the piperidine series.

Phthalyl-acetacetic Ether.—E. Fischer and H. Koch.—This compound forms, when pure, colourless prisms, melting at 124°. On prolonged boiling with dilute sulphuric acid it is saponified with formation of phthalic acid.

Quinazol Compounds.—E. Fischer and Hans Kúzel. An account of nitroso-ethyl-ortho-amido-cinnamic acid, diethyl-ortho-amido-cinnamic acid, ethyl-quinazol-carbonic acid, and ethyl-quinazol.

A New Reaction of the Aldehyds.—F. Penzoldt and E. Fischer.—For the practical execution of the test it is best to employ pure crystalline sulpho-diazo-benzolic acid. It is fresh dissolved on each occasion in about 60 parts of cold water with a little soda-lye, the substance under examination, mixed with dilute alkali and a few granules of sodium amalgam, is added, and the whole is let stand quietly. If an aldehyd is present, there appears in ten to twenty minutes a reddish violet colour, resembling pure magenta. In oil of bitter almonds it can be distinctly recognised in the dilution of 1 : 3000. This test is much more sensitive than the well-known reaction with rosaniline sulphurous acid. It succeeds with all aldehyds which are permanent in alkaline solutions. It has been

specially verified with acet-, valer-, cœnanth-, and benzaldehyd, furfurol, and glyoxal. Chloral and benzoine do not yield the reaction. Acetone and acetacetic ether yield, under the same circumstances, a deep red colour, but without the characteristic violet tone. The same applies to phenol, resorcin, pyro-catechin, if care be taken that they come in contact with the diazo compound only in presence of an excess of alkali.

Decomposition of Benziloid Bodies by Potassium Cyanide.—Fr. Jourdan.—The action of potassium cyanide is in this case evidently similar to that of a ferment, as it undergoes no change in the reaction, and as a very small proportion is sufficient for the transformation of considerable quantities of benzil.

Compounds of the Hydrazines with the Ketones.—H. Reisenegger.—An account of aceton-phenyl-hydrazin, aceto-phenon-phenyl-hydrazin, aceto-phenon-dimethyl-hydrazin, and of the behaviour of cœnanthol with phenyl-hydrazin, and of the same substance with chloral.

Cosmos les Mondes.

No. 5, September 29, 1883.

Filtration of Finely-divided Precipitates.—Lecoq de Boisbaudran.—Already inserted.

Combination-calories of the Soluble Compounds of Cadmium.—Dr. D. Tommasi.—The author gives the combining-heats of cadmium bromide, iodide, nitrate, and sulphate, as calculated by the law of thermic substitution constants, and as actually found by experiment.

No. 6, October 6, 1883.

Copper and Microbia.—It is stated that the antiseptic action of copper sulphate is slightly superior to that of salicylic and benzoic acids; twice greater than that of phenol; five times greater than that of alum, tannin, and arsenious acid; and ten times greater than that of chloral hydrate and the ferrous salts. Copper chloride is from one-third to one-half more efficient than the sulphate.

No. 7, October 13, 1883.

The death is announced of M. Plateau, emeritus Professor of Physics at the University of Ghent.

MISCELLANEOUS.

Appointment.—Mr. W. C. Young, F.I.C., &c., Public Analyst for the Poplar and Whitechapel districts, has been appointed Public Analyst for the Parish of St. George in the East, Middlesex.

Laws governing the Action of Acids upon the Rotatory Power of Alkaloids.—A. C. Oudemans.—The specific rotatory power of the mono-acid bases observed in the form of neutral salts and in aqueous solution is constant for all salts, and is independent of the chemical nature of the acid; the slight differences observed depend on the decomposing action of the water.—*Journal de Pharmacie*.

MEETINGS FOR THE WEEK

MONDAY Nov. 19th.—Medical, 8.30.

TUESDAY, 20th.—Institute of Civil Engineers, 8.
Pathological, 8.30

WEDNESDAY, 21st.—Meteorological, 7.
Society of Arts, 8.
Geological, 8.

THURSDAY, 22nd.—Royal, 4.30.
Philosophical Club, 6.30.

FRIDAY, 23rd.—Quekett Club, 8.

SATURDAY, 24th.—Physical, 3. "On the Purification of Mercury by Distillation *in vacuo*," by J. W. Clark. "On the Measurement of the Curvature of Lenses, by Prof. R. B. Clifton, F.R.S.

THE CHEMICAL NEWS.

VOL. XLVIII. No. 1252.

ON THE ESTIMATION OF PHOSPHORIC ACID AS MAGNESIC PYROPHOSPHATE,

AND THE INFLUENCE OF CERTAIN REAGENTS EMPLOYED IN SEPARATING THE ACID FROM BASES.

By DAVID LINDO.

(Concluded from p. 231).

Precipitation of P_2O_5 in presence of ammonium citrate with slight and large excess of Mg Mix., and precipitating in presence of ammonium citrate, oxalate, and chloride with excess of reagent.

June, 1883. Series W.—Solution from the salt bruised and mixed, April, 1883. Mg Mix. from burette.

Six Experiments.—In each, added to the 25 c.c. micro. solution, 55 c.c. water, 20 c.c. No. 1 NH_3 , and 1 gm. citric acid. Other conditions same as tests.

Six Experiments.—In each proceeded as above, except that only 0.5 gramme citric acid was used.

Six Tests.—Modified, *i.e.*, NH_3 before precipitation.

No. of Expt.	1 gramme Citric Acid, 12 c.c. Mg Mix. No. 1.	No. of Expt.	0.5 gramme Citric Acid, 12 c.c. Mg Mix. No. 1.	No. of Expt.	Tests Modified.
W 338	98.30	W 344	99.15	W 350	99.95
339	98.65	345	99.30	351	99.80
340	98.35	346	99.20	352	99.85
341	98.05	347	99.25	353	99.75
342	98.20	348	99.25	354	99.80
343	98.35	349	99.10	355	99.90

Average 98.32 Average 99.21 Average 99.84

The precipitates with citric acid were as white as the tests. Four of them were ignited over the blast; they lost no more weight than the tests as previously determined.

June, 1883. Series X.—Solution from the salt bruised and mixed, April, 1883. Mg Mixture from burette.

Six Experiments.—In each, added to the 25 c.c. micro. solution 45 c.c. water, 30 c.c. No. 1 NH_3 , 2 grms. citric acid, 15 c.c. Mg mixture No. 1.

Six Experiments.—In each, proceeded as above, except that 33 c.c. Mg mixture No. 1 were used.

Six Tests.—Modified as usual, and corrected for blast.

The precipitates after ignition over the Berzelius lamp were dark. Four experiments showed that they lost more weight than the tests. I have corrected the results from the average loss so found, but in all experiments with citric acid made after these, *each* precipitate was ignited over the blast.

No. of Expt.	2 grms. Citric Acid, 15 c.c. Mg Mix. No. 1. Corrected for Blast.	No. of Expt.	2 grms. Citric Acid, 33 c.c. Mg Mix. No. 1. Corrected for Blast.	No. of Expt.	Tests Modified and corrected for Blast.
X 356	98.65	X 362	99.05	X 368	99.91
357	98.50	363	99.25	369	99.76
358	98.15	364	99.65	370	99.91
359	98.10	365	99.40	371	99.86
360	98.55	366	99.45	372	99.71
361	98.40	367	99.50	373	99.81
Average	98.39	Average	99.38	Average	99.83

July, 1883. Series Y.—Solution from the salt bruised and mixed, April, 1883. Mg Mixture from burette.

Six Experiments.—In each, added to the 25 c.c. micro. solution 55 c.c. water, 20 c.c. No. 1 NH_3 1 gramme citric acid, 33 c.c. Mg Mix. No. 1. Ignited first over Berzelius lamp, then over blast.

Six Experiments.—In each proceeded as above, but in addition added 2 grammes NH_4Cl and 0.25 gramme NH_4O, O .

Six Tests.—Modified, and corrected for blast.

No. of Expt.	1 gm. Citric Acid, 33 c.c. Mg Mix. No. 1.	No. of Expt.	1 gm. Citric Acid; 2 grms. NH_4Cl ; 0.25 gm. NH_4O, O ; 33 c.c. Mg Mix. No. 1.	No. of Expt.	Tests Modified and corrected for Blast.
Y 374	99.40	Y 380	99.05	Y 386	99.71
375	99.65	381	99.25	387	99.71
376	99.20	382	99.45	388	99.76
377	99.60	383	99.35	389	99.76
378	99.30	384	99.25	390	99.91
379	99.75	385	99.35	391	99.86

Average 99.48 Average 99.28 Average 99.79

August, 1883. Series Z.—Solution from the salt bruised and mixed, April, 1883.

Six Experiments.—In each, added to the 25 c.c. micro. solution 55 c.c. water, 20 c.c. No. 1 NH_3 , 2 grammes citric acid, 15 c.c. Mg Mixture No. 1 from burette. Let settle, then added 25 c.c. Mg mixture No. 2 from the measure 4 or 5 c.c. at a time, stirring well after each addition. Ignited first over Berzelius lamp, then over blast.

Six Experiments.—In each, proceeded as above, except that at the end added 50 instead of 25 c.c. Mg mixture No. 2 from the measure, about 10 c.c. at a time.

Six Tests.—Corrected for the blast. Mg mixture from burette.

No. of Expt.	2 grms. Citric Acid; 15 c.c. Mg Mix. No. 1; 25 c.c. Mg Mix. No. 2.	No. of Expt.	2 grms. Citric Acid; 15 c.c. Mg Mix. No. 1; 50 c.c. Mg Mix. No. 2.	No. of Expt.	Tests corrected for Blast.
Z 392	99.50	Z 398	99.80	Z 404	100.01
393	99.65	399	99.75	405	100.01
394	99.80	400	100.00	406	99.96
395	99.95	401	99.90	407	99.96
396	99.60	402	99.90	408	100.06
397	99.80	403	99.90	409	100.01

Average 99.72 Average 99.88 Average 100.00

Solvent action of ammonium citrate on the precipitate, and the influence of Mg Mixture in counteracting this.

June, 1883.—Series A A.—Solution from the salt bruised and mixed, April, 1883. Mg Mix. from burette.

Six Experiments.—In each, washed the precipitate with 100 c.c. of solution composed of 2 grms. citric acid, 80 c.c. water, and 20 c.c. No. 1 NH_3 .^{*} Then washed with 100 c.c. No. 3 NH_3 . Other conditions same as tests.[†]

^{*} The NH_3 is in considerable excess of the quantity required to neutralise the 2 grammes citric acid.

[†] The 100 c.c. No. 3 NH_3 with which the precipitate was finally washed were found sufficient, but for strict comparison with the tests and for other reasons, the method adopted in testing the solvent action of ammonium oxalate and chloride, *viz.*, to wash the precipitate first with 50 c.c. No. 3 NH_3 , then with the solvent, and finally with 150 c.c. No. 3 NH_3 , would have been preferable. It would also have been better to use No. 2 Mg mixture instead of No. 1. These experiments on the solvent action of ammonium citrate were made, as the dates will show, previous to those on the solvent action of the other reagents already referred to.

Six Experiments.—In each, proceeded as above, except that to the solution containing 2 grammes citric acid I added 20 c.c. No. 1 Mg Mixture.

Six Tests.

No. of Expt.	Washed with solution contg. 2 grms. Citric Acid.	No. of Expt.	Washed with solution contg. 2 grms. Citric Acid and 20 c.c. Mg Mix. No. 1.	No. of Expt.	Tests.
A A 410	92'55	A A 416	99'90	A A 422	100'00
411	92'70	417	99'85	423	100'10
412	92'70	418	100'00	424	99'90
413	92'95	419	99'95	425	100'10
414	92'55	420	99'95	426	99'95
415	92'60	421	100'10	427	100'00
Average	92'67	Average	99'96	Average	100'01

*recipitation of P_2O_5 in presence of ammonium citrate, oxalate, and chloride; ferric oxide and alumina with large excess of Mg Mixture.**

August, 1883. Series B B.—Solution from the salt bruised and mixed, April, 1883.

Six Experiments.—Used in each:—

- 25 c.c. micro. solution.
- 50 c.c. water.
- 10 c.c. solution ferric chloride = 0'0322 gm. Fe_2O_3 .
- 10 c.c. solution aluminium chloride = 0'0225 gm. Al_2O_3 .
- 2 grammes citric acid.
- 20 c.c. No. 1 NH_3 .
- 0'5 gramme NH_4O, \bar{O} .
- 15 c.c. Mg mixture No. 1 from burette.
- 50 c.c. Mg mixture No. 2, 10 c.c. at a time from the measure.

Ignited first over Berzelius lamp, then over blast.

Six Experiments.—In each, proceeded as above, except that 0'25 gramme only of NH_4O, \bar{O} was introduced.

Six Tests.—Corrected for blast. Mg Mix. from burette.

No. of Experiment.	2 grammes citric acid 0'5 gramme NH_4O, \bar{O} 0'0322 gramme Fe_2O_3 0'0225 gramme Al_2O_3 15 c.c. Mg Mix. No. 1. 50 c.c. Mg Mix. No. 2.	No. of Experiment.	2 grammes citric acid 0'25 gm. NH_4O, \bar{O} 0'0322 gramme Fe_2O_3 0'0225 gramme Al_2O_3 15 c.c. Mg Mix. No. 1. 50 c.c. Mg Mix. No. 2.	No. of Experiment.	Tests corrected for Blast.
B B 428	99'90	B B 434	100'10	B B 440	99'71
429	100'05	435	100'20	441	99'81
430	100'20	436	99'55	442	100'01
431	100'45	437	100'35	443	99'91
432	99'85	438	99'95	444	99'96
433	98'85	439	100'15	445	100'11
Average	100'05	Average	100'05	Average	99'92

September, 1883. Series C C.—Solution from the salt bruised and mixed, April, 1883. All the Mg mixture from burette.

Six Experiments.—Proceeded in each exactly as in Nos. 428 to 433 except that *all* the Mg mixture was delivered from burette in drops.

Six Experiments.—Proceeded as above, except that half the quantity of metallic oxides was employed.

Six Tests.—Corrected for the blast.

* Except the NH_4Cl in Mg mixture none was actually introduced, but 0'3419 gramme, it may be supposed, will be formed from the Cl in the 20 c.c. metallic solutions used.

No. of Experiment.	2 grammes citric acid. 0'5 gramme NH_4O, \bar{O} 0'0322 gramme Fe_2O_3 0'0225 gramme Al_2O_3 15 c.c. Mg Mix. No. 1. 50 c.c. Mg Mix. No. 2.	No. of Experiment.	2 grammes citric acid 0'5 gramme NH_4O, \bar{O} 0'0161 gramme Fe_2O_3 0'0112 gramme Al_2O_3 15 c.c. Mg Mix. No. 1. 50 c.c. Mg Mix. No. 2.	No. of Experiment.	Tests corrected for Blast.
C C 446	99'55	C C 452	100'00	C C 458	99'96
447	100'30	453	100'00	459	99'91
448	100'15	454	99'60	460	100'11
449	100'00	455	99'85	461	99'91
450	100'20	456	100'15	462	99'96
451	99'85	457	100'00	463	99'96
Average	100'01	Average	99'93	Average	99'97

Precipitation of P_2O_5 in presence of ammonium citrate, oxalate, sulphate, and chloride; ferric oxide and alumina, with large excess of Mg Mixture.

September, 1883. Series D D.—Solution from the salt bruised and mixed, April, 1883. All the Mg mixture from burette.

Six Experiments.—Used in each, 25 c.c. micro. solution, 55 c.c. water, 10 c.c. sol. ferric chloride, 10 c.c. sol. alumina chloride, 2 grms. citric acid, 0'5 gm. NH_4O, \bar{O} , 0'25 gm. NH_4O, SO_3 , 20 c.c. No. 1 NH_3 , 15 c.c. Mg mixture No. 1, 50 c.c. Mg mixture No. 2. Ignited first over Berzelius lamp, then over blast.

Six Experiments.—In each proceeded as above, except that 1 gm. NH_4O, \bar{O} was introduced instead of 0'5 gm.

Six Tests.—Corrected for the blast.

No. of Experiment.	2 grammes citric acid. 0'5 gramme NH_4O, \bar{O} 0'25 gm. NH_4O, SO_3 0'0322 gm. Fe_2O_3 0'0225 gm. Al_2O_3 15 c.c. Mg Mix. No. 1. 50 c.c. Mg Mix. No. 2.	No. of Experiment.	2 grammes citric acid. 1 gramme NH_4O, \bar{O} 0'25 gm. NH_4O, SO_3 0'0322 gm. Fe_2O_3 0'0225 gm. Al_2O_3 15 c.c. Mg Mix. No. 1. 50 c.c. Mg Mix. No. 2.	No. of Experiment.	Tests corrected for Blast.
D D 464	100'40	D D 470	100'35	D D 476	100'06
465	100'15	471	100'35	477	100'06
466	100'15	472	100'10	478	99'91
467	100'25	473	100'20	479	99'91
468	99'90	474	100'20	480	99'96
469	100'40	475	100'50	481	100'06
Average	100'21	Average	100'28	Average	99'99

September, 1883.—Series E E.—Solution from the salt bruised and mixed, April, 1883. All the Mg mixture from burette.

Three Experiments.—In each, proceeded as in 464 to 469 as far as precipitating with 50 c.c. No. 2 Mg mixture; then, after allowing the usual time, instead of filtering through the Gooch crucible, I filtered through purified Swedish paper. Washed with 50 c.c. No. 3 NH_3 , dissolved in 10 c.c. 6 per cent HCl. Added 0'030 gm. citric acid, then very gradually (to solution made up to about 100 c.c.) 20 c.c. No. 1 NH_3 ; let settle. Added 30 c.c. No. 2 Mg Mix. After some hours filtered through the Gooch, and washed with 150 c.c. No. 3 NH_3 . Ignited first over Berzelius lamp, and then over blast.

Three Experiments.—In each, proceeded as in 470 to 475 as far as precipitating with 50 c.c. No. 2 Mg mixture. Then washed, dissolved, re-precipitated, and proceeded otherwise as above.

Three Tests.—Corrected for blast.

No. of Experiment.	Re-precipitated. 2 grms. citric acid.	0.5 gramme NH_4O_3 . 0.25 gram. $\text{NH}_4\text{O}_3\text{SO}_3$. 0.0322 gram. Fe_2O_3 . 0.0225 gram. Al_2O_3 . 15 c.c. Mg Mix. No. 1. 50 c.c. Mg Mix. No. 2.	No. of Experiment.	Re-precipitated. 2 grms. citric acid.	1 gramme NH_4O_3 . 0.25 gram. $\text{NH}_4\text{O}_3\text{SO}_3$. 0.0322 gram. Fe_2O_3 . 0.0225 gram. Al_2O_3 . 15 c.c. Mg Mix. No. 1. 50 c.c. Mg Mix. No. 2.	No. of Experiment.	Tests corrected for Blast.
EE			EE			EE	
482	99.90		485	99.95		488	99.76
483	100.00		486	99.80		489	99.91
484	99.90		487	99.85		490	99.86
Average	99.93		Average	99.87		Average	99.84

REMARKS AND CONCLUSIONS.

Influence of Heat.

Experiments (Series E) have shown that when the solution is moderately heated the results are as accurate as in the cold, but previous experiments had shown that if the solution is kept at or near the boiling-point during precipitation the results will be too high. In my experiments the error was about 0.5 per cent. In the presence of ammonium oxalate the error would probably be increased.

Effect of adding Excess of Mg Mixture.

Experiments have shown that large excess added gradually never does harm,* and that it is essential to use a large excess in the presence of ammonium chloride, oxalate, and citrate, especially the two latter, but even moderate excess added all at once makes the results too high (Series F).

Method of adding the Mg Mixture.

From a burette, a drop a second with constant stirring as recommended by Gladding is the best method, yet experiments, Series G, have shown the results will be nearly as accurate if the reagent is added about 2 c.c. at a time, stirring well after each addition.

Effect of Concentration.

When 20 c.c. No. 1 Mg Mixture were added all at once to a concentrated solution (Series G), the results were a little too high, though rather less so than when 15 c.c. were added in the same manner to a solution diluted as usual, Series F. When 12 c.c. No. 1 Mg Mix. were added one drop a second to a concentrated solution (Series H and I), the results were slightly below the truth. This is due to the NH_3 in the Mg mixture acting with more effect in the concentrated solution.† When the same quantity and strength of neutral Mg mixture was added in the same way to a concentrated solution, the results were accurate, Series L. It must be borne in mind no extraneous reagents, such as ammonium oxalate, &c., were introduced in these experiments.

Effect of Precipitating with Neutral Mg Mixture.

The precipitation in this case is not complete until ammonia is added, which should be very dilute, and delivered preferably from a burette a drop at a time with constant stirring. The precipitate is highly crystalline, occupies little space, and is washed very rapidly by suction. The results are accurate. Series K.

Influence of Ammonia.

If the precipitation takes place in the presence of much free ammonia, the precipitate will be in great part almost amorphous, very voluminous, and tedious to wash by suction; unless such salts as ammonium citrate and oxalate (or even chloride in considerable quantity) are also present, when the precipitate will be highly crystalline, and occupy little space even if the solution contains much

free ammonia. A highly crystalline precipitate is washed very rapidly by suction, and appears less soluble than the other form; but as the dilute ammonia in passing once through the precipitate is probably never saturated with it, and the less so the more rapid the washing, the lower results obtained with bulky precipitates may be partly at least due to longer contact with the fixed volume of dilute ammonia employed to wash with. Adding 10 c.c. No. 1 NH_3 before precipitating generally gave results a little lower than were obtained when it was added after.* When the precipitation was made in a solution containing 85 c.c., 11.54 per cent NH_3 , the total volume being 110 c.c., 99.63 per cent was obtained, the tests averaging 100.04. Series P.

Solvent Action of Dilute Ammonia on the Precipitate.

I have elsewhere remarked that the dilute ammonia in passing once through the precipitate is probably never saturated with it. For the purposes of this enquiry it is necessary to ascertain the solvent action under the conditions of the experiment. It has been shown this will vary according to the state of the precipitate. I made several experiments to ascertain if a highly crystalline precipitate, such as will be obtained by precipitating in presence of certain salts, or by using neutral Mg mixture, is less soluble than the more voluminous one obtained in the test experiments (not modified), where Mg mixture containing free NH_3 was used; but, washing with 200 c.c., the difference, if any, was too small for measurement. As in practice a very voluminous precipitate will rarely be obtained, I have confined the experiments given here to precipitates derived from the tests, not modified.

The precipitates (Series Q) washed with 200 c.c. No. 2 NH_3 , gave 100.04, and those washed with 600 c.c., 99.62. Series R experiments repeated gave practically the same results. The difference 0.42 per cent would represent the solvent action of 400 c.c. No. 2 NH_3 , which, on a precipitate of $\text{Mg}_2\text{P}_2\text{O}_7$ weighing 0.2 gram., would amount to 0.00084 gram. 1 litre of No. 2 NH_3 would therefore dissolve an amount of the precipitate equal to 0.0021 gram. $\text{Mg}_2\text{P}_2\text{O}_7$, and 3 litres, 0.0063 gram. As a control to the above, 3 litres of the washings with No. 2 NH_3 (collected in a clean receiver) were evaporated to small volume in a porcelain dish, transferred to a smaller dish, evaporated with addition of pure nitric acid to dryness on the water-bath, alternately moistened with nitric acid and evaporated to dryness several times; added a little nitric acid and water, heated, and passed through a small purified filter. Precipitated with molybdic reagent, and proceeded according to recent improvements in the method to recover the P_2O_5 as $\text{Mg}_2\text{P}_2\text{O}_7$. It weighed 0.0066 gram.† 3 litres of washings with No. 2 NH_3 from Series R treated in the same way, gave 0.007 gram. $\text{Mg}_2\text{P}_2\text{O}_7$, average 0.0068 gram., which is 0.0005 gram. excess of the calculated results. I am inclined to place most reliance on the latter, for, although the washings were evaporated in a tranquil atmosphere, the experiments would have been more reliable if the evaporation had been conducted as in a water analysis. Experiments were made in the same way on the solvent action of No. 3 NH_3 . The results calculated from two series of experiments showed 3 litres would dissolve 0.0086 gram. $\text{Mg}_2\text{P}_2\text{O}_7$. The actual quantity recovered from 3 litres was 0.009 gram. The rule in washing with No. 2 NH_3 would be to add 0.0002 gram. to the weight of the precipitate for every 100 c.c. used. If 200 c.c. are used, and the precipitate should weigh 0.2 gram., omitting to make the correction would cause a minus error of 0.2 per cent.‡ In washing with No. 3 NH_3 we should have to add 0.0003 gram. (nearly) to the weight of

* When the tests so modified were not slightly below the truth there can be little doubt the salt had lost water of crystallisation.

† A blank experiment made by evaporating 1 litre of the dilute NH_3 (equal in strength to 3 litres No. 2) to dryness, and testing after treating as above for P_2O_5 with molybdic reagent, led to a negative result.

‡ If Mg mixture has been added in sufficient quantity the mother-liquor will have no solvent action on the precipitate.

* Except in presence of ammonium sulphate; and when the conditions, of which a summary is given further on, are observed.

† This will be explained under remarks on the influence of NH_3 .

the precipitate for every 100 c.c. employed. Using 200 c.c. and omitting the correction would cause a minus error of 0.3 per cent with precipitates weighing as above. The results of experiments made in the course of this enquiry seem to show the precipitate is seldom obtained so pure as to warrant the full correction, but, as observed before, it is difficult to settle the point definitely by work done with a salt containing water of crystallisation.* I may here state that 100 c.c. were often found sufficient to wash a precipitate weighing after ignition 0.2 grm., while in other cases nearly 200 c.c. were consumed before the chlorine reaction disappeared; to be sure of thorough washing without testing in every experiment I always used 200 c.c.

Precipitation of P_2O_5 in Presence of Ammonium Chloride, Oxalate, and Citrate.

The influence of these salts in lowering the results has been sufficiently shown in the course of this enquiry. I believe it has generally been considered that the effect is entirely due to their solvent action on the precipitate, but the oxalate and citrate (if not the chloride) seem to hinder to some extent the reaction that determines the formation of ammonio-magnesian phosphate, for the quantity of Mg mixture that will counteract the solvent action of a given quantity of oxalate or citrate on the precipitate already formed, will not, if used as excess, precipitate all the P_2O_5 in presence of a similar quantity of oxalate or citrate, the volumes of the solutions in both cases being the same.

Mg mixture used in large excess in precipitating in presence of these salts seems to act in two ways; it counteracts the solvent action of the salts on the precipitate, and apparently by its mass overcomes, or nearly does so, the resistance which the salts in question seem to offer to the completion of the reaction. The effect of excess of Mg mixture has been considered very different by others; although its influence in counteracting the solvent action of NH_4Cl is well known, its influence in this respect (and in the other referred to) in the case of oxalate and citrate, seems to have been overlooked or ignored. It has been held that in the presence of these salts, large excess of Mg mixture will, as a rule, lead to high results from magnesium oxalate and citrate being thrown down, and that accurate results will only be obtained by accident.

In the presence of 0.5 grm. ammonium oxalate, using enormous excess of Mg mixture led to results slightly lower than the tests, Series U. In the presence of 2 grms. citric acid, using the same excess of Mg mixture gave results also slightly lower than the tests, Series Z. There is therefore no evidence whatever to show that excess of Mg mixture acts in the manner ascribed to it in the presence of such quantities of ammonium oxalate and citrate, as with ordinary care need never be exceeded in analysis, and in solutions sufficiently diluted.

The Solvent Action of Ammonium Chloride, Oxalate, and Citrate on the Precipitate.

When a solution composed of 100 c.c. water, 10 c.c. No. 1 NH_3 , and 6 grms. NH_4Cl was sucked through the precipitate, the quantity of the latter dissolved was equal to 0.0029 grm. $Mg_2P_2O_7$, making the results 98.62, the tests giving 100.06. When 20 c.c. No. 2 Mg mixture were added (and probably less would have done) to the solution of NH_4Cl , the precipitate proved absolutely insoluble in the mixture, Series J. 1 grm ammonium oxalate in 110 c.c. water and NH_3 dissolved = 0.0061 grm. $Mg_2P_2O_7$, giving 96.96. Tests 99.99, 20 c.c. No. 2 Mg mixture, rendered the solution of ammonium oxalate totally without solvent action, Series V. On reference to Series S, it will be seen that 1 c.c. No. 1 Mg mixture in excess of the

quantity required (11 c.c.) for exact precipitation, sufficed to reduce the error greatly when the P_2O_5 was precipitated in presence of 1 grm. ammonium oxalate, the result being 99.31, tests 100.04, yet the enormous excess of reagent used in presence of 0.5 grm. oxalate failed to give results quite as high as the tests, Series U.

Washing with solution containing 2 grms. citric acid and excess of NH_3 dissolved = 0.0147 grm. $Mg_2P_2O_7$ giving 92.67, tests 100.01, 20 c.c. Mg mixture No. 1 added to the solution of citric acid, rendered the solvent action little more than the dilute ammonia No. 3, Series AA. Here, again, on reference to Series X it will be seen how small an excess of Mg mixture used in precipitating in presence of 2 grms. citric acid reduced the error enormously, the results being 98.39 with 15 c.c. Mg mixture, tests 99.83.

The conclusion I arrive at from results obtained in the course of this investigation, is that the separation of P_2O_5 by the oxalic acid method will, if the process is conducted with the simple precautions indicated in this paper, be very nearly if not quite as accurately effected as by the molybdc method, even in the presence of considerable quantities of ferric oxide and alumina.

The rule is to use only moderate excess of ammonium oxalate in precipitating the lime; to use citric acid pretty freely in presence of the metallic oxides; to precipitate first with a rather weak Mg mixture, using some excess, and delivering from a burette in the manner described. Let the precipitate settle, then add a large volume of stronger Mg mixture, preferably delivered also from a burette in drops, with constant stirring. In the presence of a moderate amount of ammonium sulphate, there will be a slight plus error; if more accurate results are desired they can be obtained by a second precipitation; except in the presence of sulphate this will be quite unnecessary.

NOTES.

Precipitates obtained in test experiments contracted greatly on ignition, and split in rings.

Highly crystalline precipitates occupying little space, obtained by precipitating in presence of certain salts or with neutral Mg mixture, were much more bulky after ignition than the tests, and formed a porous mass. In presence of much citric acid they were very dark after ignition over the lamp, but a few minutes' exposure to the blast rendered them perfectly white. The loss, however, rarely amounted to 1 milligram, and averaged about 0.0006 grm.

The following experiments illustrate that in mixing citric acid solutions of ferric chloride and ammonia together, there will be a striking difference in the results according to the order in which they are mixed.

Solutions used.

Citric acid; 50 c.c. contained 0.5 grm. acid.

Ferric chloride containing some excess of HCl; 10 c.c. gave 0.035 grm. ferric oxide.

No. 1 NH_3 containing 6.34 per cent.

Micro-solution, as in former experiments.

Mg mixture No. 1.

The reagents were mixed in the order given below:—

Experiment 1.

5 c.c. solution ferric chloride.

50 c.c. citric acid solution; colour of mixture, bright yellow.

10 c.c. No. 1 NH_3 ; colour changed to light yellowish green.

20 c.c. micro-solution.

11 c.c. No. 1 Mg mixture (burette) precipitate fell white or practically so.

Experiment 2.

50 c.c. citric acid solution.

10 c.c. No. 1 NH_3 .

5 c.c. solution ferric chloride; colour of mixture, orange.

20 c.c. micro-solution.

* The lower results obtained with very voluminous precipitates were due to greater solvent action in washing, and not to greater purity, as was proved by recovering the P_2O_5 from some of the washings.

11 c.c. No. 1 Mg mixture (burette) precipitate fell deeply stained with ferric oxide.

Experiment 3.

Mixed the three first reagents again in the two different orders given above, and heated to the boil. No change of colour in either.

These experiments show the ammonia should always be added after the citric acid and iron, which in analysis is always done, though the effect of doing the reverse does not seem to have been noticed before.

Falmouth, Jamaica, B.W.I.,
October 2, 1883.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING OCTOBER 31ST, 1883.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the Water Examiner, Metropolis Water Act, 1871.

London, November 6th, 1883.

SIR,—We submit herewith the results of our analyses of the 189 samples of water collected by us during the past month, at the times and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from October 1st to October 31st inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and the Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples taken for analysis.

The Chelsea Company's water, as delivered from the stand-pipe opposite the Horse Guards, was, during the first week of the month, slightly turbid from the presence in suspension of a small quantity of mineral matter. The turbidity was enquired into by us, and was found to be confined to that locality, and to be dependent on certain works in connection with the water supply of the neighbourhood, rendered necessary by the erection of new buildings.

Excluding the first week of the Chelsea Company's supply, at the Horse Guards, the 181 samples of water submitted to examination, were, with the exception of three samples recorded as "very slightly turbid," clear, bright, and well filtered.

The water supplied to the metropolis throughout the entire month has been of most excellent quality.

With respect to the frequently considerable variations with season, in the always small amount of organic matter, met with in London water, it results from our experiments that the mean amount of organic carbon in the water furnished during October by the Companies taking their supply exclusively from the Thames, was just 0.100 part in 100,000 parts of the water, the average amount for the past six months having been 0.116 part, corresponding to about 2.10ths of a grain of organic matter per gallon. With the coming on, however, of winter, the low amounts of organic carbon, and consequently of organic matter,

present in the water for so many months past, can scarcely any longer be expected.

We are, Sir,

Your obedient Servants,
WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

DETERMINATION OF THE EQUIVALENTS OF COPPER AND ZINC BY MEANS OF THEIR SULPHATES.

By M. H. BAUBIGNY.

THANKS to the beautiful and classic researches of M. Stas on the reciprocal relations of the atomic weights of certain simple bodies, we now possess all the elements necessary for calculating with great precision, by the aid of experimental data, the atomic weights of other bodies, and for comparing the results obtained by the different methods employed.

Among the numbers important to be known, only the proportion of the atomic weights of oxygen and hydrogen has not been determined with a sufficient exactitude, notwithstanding the researches of the most eminent savants who have occupied themselves with this subject.

To avoid prolonging the calculation and to render it independent of the cause of error attached to the uncertainty which exists on the value of this proportion, represented at present by 7.98 , if $H=1$, the author takes as a basis $O=8$. By operating thus the equivalents of the metals will depend only on the proportion of the equivalents of oxygen and sulphur, since his determinations have been made by means of an anhydrous sulphate and in the state of a simple salt.

M. Stas has established the proportion of the equivalents of oxygen and sulphur with extreme care, and the author, with him, takes $S=16.037$. For comparison with older determinations he proposes each time to calculate the equivalent of the metal as a function of the two numbers $O=8$ and $S=16$.

Copper.—The sulphate is prepared by dissolving in sulphuric acid, either the metal, or artificial atacamite, all these bodies being as pure as possible. When the solution in sulphuric acid is effected, the excess of acid is evaporated away, the salt taken up in water, filtered, and let crystallise. The decanted mother-liquor is again evaporated to crystallisation, and finally the mother-liquors of this second crystallisation are evaporated to dryness, yielding the product which the author calls evaporation-residues. If the salt is pure the same number should be found for the atomic weight of copper with the sulphate of the first crystallisation and with that of the residues.

a. A portion of the first crystallisation, after exposure to 440° for three hours, weighed 4.022 grms. The weight remained constant on heating anew for ten hours. It was calcined at the temperature of melting gold, the process being twice repeated; there remains copper oxide $=2.0035$ grms.; loss $(SO_3) = 2.0185$ grms., whence the equivalent $Cu=31.739$ if $S=16.037$, and $Cu=31.703$ if $S=16$.

b. On operating in the same manner with a part of the evaporation-residues we have— $Cu=31.739$ if $S=16.037$, and $Cu=31.693$ if $S=16$; for 2.596 of sulphate left on calcination 1.293 CuO . As a mean we have, for $S=16.037$, $Cu=31.734$, and for $S=16$, $Cu=31.698$.

Berzelius, on reducing copper oxide by hydrogen, found 31.65 ; Erdmann and Marchand, by the same method, 31.728 ; M. Dumas, guided by the hypothesis of Prout, concluded from his observations that $Cu=31.75$.

The unpublished experiments of M. Debray prove that cupric oxide is dissociated at high temperatures, and is transformed into cuprous oxide with dissociation-tensions fixed at each temperature, and that inversely if cuprous

oxide is allowed to cool in presence of oxygen, the re-transformation is entirely effected much above 440°. The author's results are, therefore, independent of this phenomenon of dissociation.

Zinc.—The sulphate is prepared by dissolving distilled zinc in pure dilute sulphuric acid, taking care that a part of the metal is left undissolved. The liquid is filtered, evaporated to dryness, and raised slowly to 440° in order to expel the excess of acid; then about 150 grms. of the sulphate are dissolved in 10 litres distilled water; a little of the zinc is precipitated by hydrogen sulphide, the vessel is closed, and the whole is allowed to stand for twenty-four hours, shaking from time to time. This zinc sulphide reacting upon the traces of the more sulphurable metals (lead, cadmium, &c.), which may be present, precipitates them. They are filtered off, and the filtrate is saturated with sulphuretted hydrogen, which precipitates the zinc almost entirely. This sulphide, washed several times with water slightly acidulated with sulphuric acid, and then dissolved in the concentrated acid, furnishes the zinc sulphate used in the author's determinations.

The salt dried at 440° was divided into three parts by fractional crystallisations, exactly as in the case of copper, the first portion and the residues being operated upon.

a. A part of the first crystallisation after exposure for seven hours to 440°, weighed 6.699 grms. The weight did not vary on re-heating for eight hours. It was calcined at the melting-point of gold, repeating the process twice: there remained $\text{ZnO} = 3.377$ grms., loss $(\text{SO}_3) = 3.322$ grms., whence the equivalent $\text{Zn} = 32.700$ if $\text{S} = 16.037$, and $\text{Zn} = 32.662$ if $\text{S} = 16$.

b. On operating in the same manner with a part of the evaporation-residues, we have— $\text{Zn} = 32.708$ if $\text{S} = 16.037$, and $\text{Zn} = 32.671$ if $\text{S} = 16$; for 8.776 grms. sulphate left 4.4245 zinc oxide. But as this oxide is absolutely fixed in the air at the temperature of melting gold, as appears from the researches of H. Sainte-Claire Deville, we are justified in assuming, as the mean of the above results,— $\text{Zn} = 32.704$ if $\text{S} = 16.037$, and $\text{Zn} = 32.667$ if $\text{S} = 16$.

Berzelius and Gay-Lussac, by the oxidation of zinc, came at first to the number 32.776, which they afterwards corrected to 32.258. Pelouze deduced the equivalent 32.5 from the anhydrous lactate. Marchand, by calcining the nitrate of a known weight of zinc, inferred, from the weight of the residual oxide, 32.55; whilst Favre, by the calcination of the oxalate, and Jacquelin, by the calcination of the sulphate, found the number 33.—*Comptes Rendus*, October 22, 1883.

PROCEEDINGS OF SOCIETIES

CHEMICAL SOCIETY.

Thursday, November 15, 1883.

Dr. W. H. PERKIN, F.R.S., President, in the Chair.

THE following certificates were read for the first time:—W. P. Bloxam, G. C. Chambers, A. Cobb, A. E. Ekins, F. P. Haviland, W. H. R. Kerry, F. Keeling, J. J. Pilley, J. Phillips, M. Percy, A. W. Rogers, A. Smithells, W. J. Saint, G. Smith. It was announced that a ballot would take place at the next meeting, December 6.

Mr. C. O'SULLIVAN then read a paper on the "*Estimation of Starch*." The author has used the method described below during the last eight to ten years for estimating starch in cereals and malted grain. The method may be briefly described as follows:—The finely ground grain is successively extracted with ether, alcohol (sp. gr. 0.90), and water at 35° to 38°. The starch in the washed residue is gelatinised by boiling with water, cooled to 63°, and converted by diastase into dextrin and maltose. If a quantitative determination of these two products be

made, the starch originally present can be calculated. The author describes the method as follows:—About 5 grms. of the finely-ground flour are introduced into a wide-necked 100 c.c. flask, and just saturated with alcohol, sp. gr. 0.82; 20 to 25 c.c. of ether are added. After standing several hours with occasional shaking, the ethereal solution is decanted through a filter, and the residue in the flask washed with ether. To the residue 80 to 90 c.c. of alcohol, sp. gr. 0.90, are added, and the mixture warmed to 35° to 38° for a few hours; the alcoholic solution is then decanted through the same filter, and the residue washed with alcohol, sp. gr. 0.90, at 35° to 38°. The residue in the flask and on the filter is washed into a 500 c.c. beaker, and the beaker filled with water. In about twenty-four hours the solution is decanted through a filter, and the residue washed with water at 35° to 38°. The residue in the beaker and on the filter is washed, with a short camel-hair brush and a fine jet, into 100 c.c. beaker. The whole is then boiled for a few minutes in the water-bath, with constant stirring, to gelatinise the starch; the beaker and its contents are cooled to 62° to 63°, and about 0.03 gm. of diastase added; the digestion at 62° is continued for an hour. The beaker is then boiled for eight to ten minutes, the solution filtered into a 100 c.c. measuring flask, the residue carefully washed with successive small quantities of boiling water, and the whole made up to 100 c.c. at 15.5°. The ether frees the grains from fat, &c.; the alcohol (0.90) removes the sugars, albumenoids other than casein, &c., whilst water at 35° to 38° dissolves out the amylams. Dextrin and maltose are the sole products of the action of diastase on starch. The diastase is prepared as follows:—2 to 3 kilos. of finely-ground pale barley malt are mixed with sufficient water to saturate and cover the whole. After standing three or four hours the mass is squeezed with a filter-press. If not bright the liquid is filtered. To the clear solution, alcohol, sp. gr. 0.83, is added as long as a flocculent precipitate falls; as soon as the supernatant liquid becomes milky, the addition of alcohol is discontinued. The precipitate is washed with alcohol, 0.86 to 0.88, dehydrated with absolute alcohol, pressed, and dried *in vacuo* over sulphuric acid until its weight is constant. Diastase thus prepared is a white, friable, easily soluble powder, which retains its activity for a considerable time. 5 grms. of barley flour thus treated with 0.03 gm. diastase gave 100 c.c. at 15.5°, having sp. gr. 1.01003, which represents 25.39 grms. solid matter (taking 1.00395 as the sp. gr. of a solution containing 1 per cent of starch products). 9.178 grms. of this solution reduced 0.241 gm. cupric oxide, and 200 m.m. of it gave a deviation in the Soleil Wentzke-Scheibler saccharimeter of 21.1 divisions. Thus we have $0.241 \text{ gm.} \times 0.7256 = 0.1748 \text{ gm. maltose}$ in 9.178 grms; in the 100 c.c., or 101.003 grms., there are 1.923 grms. maltose; 1 gm. of maltose in 100 c.c. gives a deviation in 200 m.m. of 8.02 divisions, and 1 gm. of dextrin in 100 c.c. gives 11.56 divisions. So $1.923 \times 8.02 = 15.422$, the optical activity of the maltose; and $21.1 - 15.422 = 5.678$, the optical activity of the dextrin. Therefore, in 100 c.c., there are—

$$\frac{5.678}{11.56} = 0.491 \text{ gm. of dextrin.}$$

We have, therefore, in the 100 c.c., maltose 1.923 grms., dextrin 0.491 gm., diastase 0.03 gm., = 2.444 grms. out of 2.539 solids, as indicated by the sp. gr. Of this deficiency of 0.095 gm. 0.083 proved to be α -amylam which had not been washed out. 1 part of starch yields 1 part of dextrin, and 1 part of starch yields 1.055 maltose. The starch represented by the above numbers is, therefore,—

$$\begin{aligned} \text{Dextrin} &= 0.491, \\ \text{Maltose } \frac{1.928}{1.055} &= 1.822, \end{aligned}$$

or a total of 2.313 grms. starch from 5 grms. of barley. Barley thus contains 46.26 per cent of starch; a second experiment gave 46.38 per cent. The author gives many

other determinations in detail. Barley malt contains 39.9 per cent; wheat, 55.4; wheat malt, 43.26 and 43.53; Rye, 44 to 46; Rice, 75 to 77; maize, 54 to 58; Oats, 35 to 38 per cent. In some experiments the author estimated the starch in a sample of pure starch containing 89.36 per cent of dry starch. He obtained 87.72 per cent and 89.54 per cent. The author states as the result of his experience with the method, that the difference in results obtained by any two observers need not exceed 0.5 per cent of the total starch.

Dr. ARMSTRONG said the paper was one of great value, and the amount of work involved was not by any means represented by the length of the paper. The progress of physiological chemistry must depend upon the accuracy of the means at our disposal of estimating the various constituents. Such researches must contribute a great deal to the investigation of vital problems.

In answer to Dr. Armstrong,

Mr. O'SULLIVAN stated that methylated spirit could be used in the extraction of the flour.

Dr. PERCY FRANKLAND then read a paper on the "*Illuminating Power of Ethylene when Burnt with Non-luminous Combustible Gases.*" The ethylene was prepared from methylated spirit and strong sulphuric acid, and purified by passing over various absorbents. It contained CO_2 , 0.05; O, 0.94; C_2H_4 , 97.52; N, 1.49. The non-luminous combustible gases experimented with were—hydrogen, prepared as usual from zinc and sulphuric acid; carbonic oxide, from potassium ferrocyanide and strong sulphuric acid; and marsh-gas. The product obtained by heating sodic acetate and soda lime was so impure that the author was obliged to prepare pure marsh-gas by decomposing zinc-methyl with water. The illuminating power was determined by an Evans's photometer; a Referee's burner and sperm candles being used. A sample of the gas was always taken at each determination and analysed. The illuminating power of ethylene, supposing 5 cubic feet per hour could be burnt, was found to be 68.5 candles. The illuminating power of ethylene when mixed with hydrogen shows an almost uniform diminution from 68.5 to zero when 90 per cent H is used. A mixture containing 25 per cent of ethylene had an i.p. 20 candles. In every case the i.p. of mixtures of ethylene and carbonic oxide was found to be less than that of the corresponding mixtures of ethylene and hydrogen. With marsh-gas it was found that mixtures rich in ethylene had about the same luminosity as those containing hydrogen and carbonic oxide, but that the i.p. of mixtures rich in marsh-gas greatly exceeded that of the corresponding mixtures with the two other gases. The intrinsic luminosity of the ethylene, calculated for a uniform consumption of 5 cubic feet per hour, continually increases as the percentage of marsh-gas rises. Thus the ethylene in a mixture containing 92 per cent of marsh-gas gives a light of 175 candles calculated for 5 cubic feet consumed per hour. The high illuminating power of coal-gas, considering the small quantity (4.51 per cent) of illuminating hydrocarbons that it contains, is probably explained by this great value of marsh-gas as a diluent. The explanation of this behaviour of marsh-gas is to be looked for in the quantity of heat developed in its combustion. Thus 1 mol. of H yields 68,924 units of heat; of CO, 67,284 units; of marsh-gas, 209,008 units. The author promises some further experiments on the effects of incombustible diluents.

Dr. FRANKLAND many years ago had made somewhat similar experiments, and had then stated that marsh-gas was a diluent, and gave no illuminating power to coal gas. He experimented with a fish-tail burner. There seemed to be no doubt that the apparent rise of 4 to 5 candles in the illuminating power of coal-gas by the wonderful "Referee's burner," was largely due to the development of the illuminating power of the marsh-gas. For lighting purposes much marsh-gas was objectionable from the CO_2 produced and the quantity of heat developed, but where gas was used for heating purposes the case was quite different,

and a large percentage of marsh-gas was most advantageous, owing to its great heating power.

Mr. G. S. JOHNSON then read a paper "*On the Products of Decomposition of Aqueous Solution of Ammonium Nitrite.*" The main points of interest observed are as follows:—No oxide of nitrogen is formed by alkaline solutions of pure ammonium nitrite. Nitrogen is evolved from such solution at temperatures below 100°C .; the evolution is facilitated by the pressure of spongy platinum. Pure nitrogen can be obtained by adding crystallised cupric chloride to solutions at the ordinary temperature. If solutions of ammonium nitrite be acidulated 40 per cent of nitric oxide is evolved. The author states that 2 per cent of the gas evolved by the action of cupric chloride consists of nitrogen in a peculiarly active state, setting free iodine from hydriodic acid, and forming ammonia when mixed with hydrogen and passed through a red-hot tube with spongy platinum. This active nitrogen is decomposed at a red heat, and is not produced if the temperature of the solution be raised above 90° .

Dr. ARMSTRONG suggested that the nitrogen should be made in some other way. He did not think that passing the evolved gas over red-hot copper ensured the absence of oxygen. The quantity of ammonia formed was extremely minute; it seemed also excessively improbable that such an active form of nitrogen should exist.

Dr. E. B. SCHMIDT then read a short paper "*On the Estimation of Iron by Potassium Bichromate.*" The author recommends the above process; but states that zinc should not be used to reduce the iron, as it interferes with the end reaction with potassium ferricyanide. He prefers Kessler's method of reduction with stannous chloride. The author considers the reduction with sulphite of sodium tedious.

Mr. RILEY said that the bichromate method was almost universally used for the estimation of iron; the difficulty when zinc was employed was also well known. Numerous analyses were constantly being made in his laboratory; the reducing agent employed being sodium sulphite. The whole subject was thoroughly discussed by him in a paper published some time back in the *Chemical Society Journal* (1877, vol. ii., p. 24, and 1862, xv., 311).

The Society then adjourned to Dec. 6th.

OBITUARY.

SIR WILLIAM SIEMENS.

WE much regret to have to announce the sudden death of Sir William Siemens, which occurred on the evening of Monday last, the 18th inst., in consequence of an injury to the heart, brought about by a fall a fortnight previously. Walking home from a scientific meeting on the afternoon of Monday, the 5th inst., he tripped and fell while crossing Hamilton Place. Though for a day or two no apparent harm resulted, it was soon found that the heart had been—it was hoped slightly—injured, or, at all events, that the shock, acting on a previously existing morbid condition, had had injurious effects. Still there seemed no reason to fear that rest would not repair the mischief, till on Monday last, quite suddenly, the end came.

By his death English science has suffered a severe loss, and a loss which will not readily be made good. At a time when the tendency of science is more and more to specialise itself, and scientific men are often compelled to study one particular branch of a subject alone, it is very rare to find a mind like that of Sir William Siemens, who devoted himself to many distinct branches of science, and yet excelled in them all. Not only has he done much for the advancement of pure science, but it may be said without contradiction that he has, beyond all his

contemporaries, promoted the practical application of scientific discoveries to industrial purposes. He was an ardent scientific discoverer, a large and successful manufacturer in at least two distinct branches of industry, an engineer of high rank in the profession, and besides this he was a shrewd and clear-headed man of business.

Charles William Siemens was born at Leuthe, in Hanover, on the 4th of April, 1823. He was educated at the Gymnasium at Lübeck, afterwards at the Polytechnic School at Magdeburg, and finally at the University of Göttingen. Here he studied under Wöhler and Himly. In 1842 he became a pupil in the engine works of Count Stolberg, and here he laid the foundation of his engineering knowledge—knowledge he afterwards turned to such good practical account. The fact that he was one of a family of inventors makes it rather difficult to say what was the precise personal share he had in the many inventions for which the world is indebted to the four gifted brothers—Werner, William, Carl, and Frederick. They all worked so harmoniously together—the idea suggested by one being taken up and elaborated by another—that it is hardly possible to attribute to each his own proper credit for their joint labour. The task, too, is rendered all the harder by the fact that each brother was always ready to attribute a successful invention to any of the family rather than to himself. It may, however, be said that in electrical discovery the two brothers, William and Werner, were principally associated, while the regenerative furnace is due not only to William, but also to Frederick. It was to introduce to the English public a joint invention of his own and his brother Werner in electro-gilding that William Siemens first came to England. This was in 1843. Speaking two years ago to the Birmingham and Midland Institute, Dr. Siemens, as he was then, gave an interesting and somewhat touching account of the difficulties which not unnaturally beset the young foreign inventor, so ignorant of the language of the country that his first visit was to an “undertaker,” under the impression that he was a suitable person to take up and bring out his invention. Thanks to the kindly discrimination of Mr. Elkington, who was able to perceive that certain processes described in some of his own patents could only be carried into effect by the improvements of the Siemenses, he was able to dispose of his invention so far successfully that he was induced in the following year to come back again on a similar errand. This time it was his “chronometric governor,” an apparatus which, though not very successful commercially, introduced him into the engineering world, and was really the cause of his settling in this country. The chief use of this apparatus, intended originally for steam engines, has been found in its application to regulate the movement of the great transit instrument at Greenwich.

His studies in the dynamical theory of heat led him to pay special attention to methods of recovering the heat generally allowed to run to waste in various engineering and manufacturing processes. The first application of these researches was in the regenerative steam engine which he set up in 1847 in the factory of Mr. Hicks, at Bolton. In this superheated steam was employed, but its use was attended with certain difficulties which have prevented the commercial introduction of the invention. The Society of Arts may have the credit of being the first public body in England which recognised the value of the principle by awarding Mr. Siemens a gold medal in the year 1850 for his regenerative condenser. The direction in which he was then working was stated in a paper he read before the Institution of Civil Engineers in 1853 on the conversion of heat into mechanical effect. This paper gained him the Telford Premium and Medal of the Institution. In 1857 William Siemens, in connection with his younger brother and then pupil, Frederick, turned his attention to regenerative furnaces for metallurgical purposes. The regenerative gas furnace, as it is certainly the greatest invention due to the Siemenses, so is the one in which William Siemens is believed to have had the largest share.

The first successful application of these furnaces was in 1861. The principle of the regenerative furnace is tolerably well known; it may suffice to say here that its main feature consists in an arrangement by which the waste heat of the products of combustion is utilised by being imparted to the air and to the gaseous fuel by which combustion is supported. This is effected by causing the products to pass through chambers in which the heat is taken up by masses of brickwork, and afterwards passing the in-coming currents of air and gas among the heated brickwork. The earlier applications of this principle to steel and glass making have been followed by its extension to many other industrial purposes in which great heat is required, the powers of the furnace being only limited in practice by the nature of the materials of which it can be constructed.

The application of the furnace to the making of iron and steel naturally led the attention of its inventor to other improvements in the same manufacture. In 1862 he endeavoured to reduce to practice the result of Reaumur's experiments in making steel by fusing malleable iron with cast steel. After some years experimenting the Siemens process of steel making was perfected, and a little later still the Siemens-Martin process. In the latter, scrap-iron is melted in a bath of pig-iron on the hearth of the furnace; in the former, ore is reduced. The production of steel in this country under Sir William Siemens's processes was over 340,000 tons in 1881.

But if the inventions of this regenerative furnace and of improved processes for steel making are those which are most likely to keep alive in future years the memory of their inventor, it is just now with the electric light that the name of Siemens is most closely associated in the popular mind. The precise date at which he may be said to have commenced his work in this direction can hardly be given. It was in 1867 that his classical paper on the conversion of dynamical into electrical force without the aid of permanent magnetism was read before the Royal Society. Strangely enough, the discovery of the same principle was enunciated at the same meeting of the Society by Sir Charles Wheatstone, while there is yet a third claimant in the person of Mr. Cromwall Varley, who had previously applied for a patent in which the idea was embodied. It, therefore, can never be quite certain who was the first discoverer of the principle on which modern dynamo machines are constructed. As regards the Siemens discovery, the originator of the idea was Dr. Werner Siemens, who on being shown an electrical motor constructed without permanent magnets, immediately saw that a generator without permanent magnets was equally possible. The details, however, of the construction of the Siemens machine, and the various improvements by which it has been brought to its present form or rather forms (for there are, of course, several varieties) are due alike to the younger and the elder brother. And the same may be said of the various inventions connected with telegraphy and the electric light which emanated from the great firm of Siemens Brothers. Some of these were entirely worked out by one, some by the other brother, more were the joint production of both, but no attempt was made to separate them or to discriminate. How great were the inventive resources of Sir William is well shown by the saying common in his workshops, that as soon as any particular problem had been given up by everybody as a bad job, it had only to be taken to Dr. Siemens for him to suggest half-a-dozen ways of solving it, two of which would be complicated and impracticable, two difficult, and two perfectly satisfactory.

As regards telegraphy the most important work executed by the firm was the laying of the Direct United States Cable in 1874, for which work that remarkable vessel the *Faraday* was built after the designs of Sir William Siemens. A good instance at once of the versatility of Sir William's talents and of his engineering skill is given by the arrangement of the screw propellers in this ship. Their shafts (the *Faraday* is a twin screw) are set at a

slight angle, diverging, not outwards, as has often been proposed, but inwards, towards each other. The effect of this is that the thrust of each propeller, when used singly for steering purposes, acts at a much more effective angle, and the result is that the vessel can turn in her own length when the engines are worked in opposite directions. The *Faraday* is most completely fitted up with every possible appliance for cable laying, grappling, and recovering lost cables, but the above small detail is only referred to here as illustrating the way in which Sir W. Siemens dealt with a purely engineering question, which might have been considered quite beside the ordinary direction of his work. To record fitly what he and his firm have done for the advancement, not only of electric lighting, but of the various practical uses of electricity, would involve the enumeration of an infinity of technical details, each comparatively unimportant, but each fitting into its own place and serving to produce a complete whole. To enter fully into the amount of electric lighting work effected by them would invite comparisons which at the present moment are above all things to be avoided. It may, however, be said that if a careful examination were made of the working installations of the electric light, it would be found that a very considerable portion of the real work done had been done by the firm of Siemens Brothers. At the Paris Exhibition they were *facile principes*, at Munich, at Vienna, at the Crystal Palace, they were alike conspicuous. Visitors to the just-closed Fisheries Exhibition will remember how large a share of lighting there was effected by Messrs. Siemens. As regards the electrical transmission and conveyance of power, this is a field they have made peculiarly their own. With the exception (and an exception of undoubted importance) of storage batteries, the advances in this direction are principally due to them. The Berlin electric railway and that at Portrush are alike the work of one or other branch of the firm, while those who ever had the pleasure of being shown round his country house near Tunbridge Wells by Sir William can best realise how much he individually did to reduce to human servitude the forces of that mysterious power of which he was so great a master. Not only did electricity perform a large part of the actual work of the farm, sawing wood and pumping water, but it was made to supply in part the place of the sun itself, and assist the growth of plants and fruits. And here we find the practical results of scientific work merging into the researches which have not yet borne their practical effects. Working at the subject of the electric light had of late led Sir William Siemens to considerations of the nature of light itself. The tendency of some of these thoughts is shown by certain of his recent communications to the Royal Society, including his last paper of all, in April last, "On the Dependence of Radiation on Temperature," and these, again, influenced by his earlier studies on the conservation of energy, led him to one of the most recent of his researches—that which produced his theory of the conservation of solar energy. Almost alone among all the results of his life's work, this theory of his dealt with a question not affecting—or at least not immediately affecting—human welfare. Whether from its novelty or as emanating from one not claiming to be an authority on the subject, the theory met with not a little sharp criticism when it was first put forward. Had its author lived but a few years longer he would, doubtless, have laboured to strengthen it with yet further observation and argument. As it is, it must remain as a daring and original suggestion, the effort of a keen and sagacious mind to bring to fresh subjects the experience and the knowledge accumulated by work of a totally different sort.

But to turn back again to those practical applications of scientific labour which were the real life-work of the subject of this notice—since without at least some mention of them the memoir would be still more incomplete than it is—almost a bare enumeration must suffice, but at least it will serve to show how varied were the talents we have

just lost. The process of "anastatic printing," a process only superseded by recent advances in photographic processes, was due to William and Werner Siemens. It was described by Faraday in 1845. Faraday, too, it may be noted, had for the subject of his last lecture at the Royal Institution the advantages of the Siemens furnace. Improvements in calico printing, the invention of a double cylinder air-pump and of a water metre, are also among the earlier work of William Siemens. Among more recent inventions may be noticed his bathometer, for measuring the depth of the sea without a sounding line, his electrical furnace, his electrical thermometer and pyrometer, his rotatory furnace for the production of iron and steel by the direct process, his deep-sea electrical thermometer, and his regenerative gas-burner.

Sir William Siemens was elected a Fellow of the Royal Society in 1862, and in 1869-70 he served as one of the Council. He became a member of the Institution of Civil Engineers in 1854, and has been on its Council for some years. He was the first President of the Society of Telegraph Engineers, and served a second time in that capacity. He has been President of the Institution of Mechanical Engineers, of the Iron and Steel Institute, and of the British Association. He was Chairman of Council of the Society of Arts, and was to have delivered the opening address of that society's session on Wednesday.

The honours he has received for his inventions and discoveries are very numerous. As above mentioned, the Society of Arts gave him a gold medal for his regenerative condenser in 1850. In 1874 the same society awarded him their Albert Medal for his improvements in metallurgy. At the Exhibitions of 1851 and 1862 he received prize medals, and in 1867 he was awarded a *grand prix* at the Paris Exhibition for his regenerative gas furnace and steel process. The Civil Engineers awarded him their Telford Medal in 1853, and only last week the same institution voted him their Howard Prize. This prize, which is given quinquennially to the inventor of an improved process connected with iron-making, has only been once awarded before, to Sir Henry Bessemer. In 1875 he received the Bessemer Medal of the Iron and Steel Institute. In April last he received the honour of knighthood in recognition of his scientific services. He was honorary member of various foreign scientific societies, and possessed several foreign Orders, among them the Legion of Honour. His contributions to scientific literature have been very numerous. Some of them have been referred to above, others will be found in the records of the Royal Society, the British Association, the Institution of Civil and Mechanical Engineers, the Society of Arts, and other bodies. This brief record may serve to show how valuable was the life that has just passed away, how great the loss of what a few more years of strenuous work might have yielded. Those who knew him may mourn the kindly heart, the generous, noble nature, so tolerant of imperfect knowledge, so impatient only at charlatanism and dishonesty; the nation at large has lost a faithful servant, chief among those who live only to better the life of their fellow men by subduing the forces of nature to their use. Looking back along the line of England's scientific worthies, there are few who have served the people better than this, her adopted son, few, if any, whose life's record will show so long a list of useful labours.—*The Times*.

Platinised Magnesium as a Reducing Agent.—M. Ballo.—Platinised magnesium promises to be a powerful reducing agent. The author added to a few c.c. water, nitrobenzol and alcohol, enough to effect solution. Magnesium, with the addition of a few drops of platinum chloride, occasioned a slight escape of gas, and the filtrate contained aniline. For the detection of nitrobenzol this kind of reduction may prove more advantageous than that with metals and acids, as the base is at once obtained in a free state.—*Berichte der Deutschen*.

CORRESPONDENCE.

BUNSEN'S GASOMETRY.

To the Editor of the Chemical News.

SIR,—In the article you were good enough to publish in the *CHEMICAL NEWS*, vol. xlviii., p. 229, on "A New Residual Product from the Distillation of Coal," I find some omissions have occurred which I hasten to correct. "Bunsen, in his 'Gasometry,'" should read—Bunsen, in the first edition of his "Gasometry." Many of your readers will know that in the last edition of the above work, published in 1877, a method is given for the extraction of benzol from coal-gas by means of alcohol, and this quantity so obtained is a trifle over what I am able to extract on the large scale. But, in addition to benzene, there is toluene, xylene; hexylene and other olefines; pentane and other paraffins; the ethine series; acids, bases, and naphthalene, and probably other substances. Without we know *accurately* what there are, how can we depend upon combustions of mixtures of these vapours? I hope to deal with the subject more completely during next month in a paper to be read before the Society of Chemical Industry.—I am, &c.,

GEORGE E. DAVIS.

The Manchester Chemical Club,
November 20, 1883.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvi., No. 17, October 22, 1883.

Force of Induction due to the Variation of Intensity in the Electric Current of a Multiplier with a Flat Spiral, and the Comparison of this Force with that exerted at Great Distances by a Spherical Solenoid or an Artificial Solenoid Sun.—M. Quet.—A mathematical paper which does not admit of useful abridgment.

Determination of the Equivalents of Copper and Zinc by Means of their Sulphates.—H. Baubigny.—See p. 243.

Transformation of Hydrocarbides into the Corresponding Aldehyds by Means of Chloro-chromic Acid.—A. Etard.—Chloro-chromic acid combines in definite proportions with the hydrocarbides. These compounds are split up by water into an aldehyd and a salt of chrome.

No. 18, October 29, 1883.

Congelation-point of Alkaline Solutions.—F. M. Raoult.—The author divides the bases upon which he has experimented into two groups; the former comprising the alkaline earths and alkalies, along with tetra-methyl-ammonium and tri-methyl-ethyl-ammonium, whilst the latter includes ammonium, methyl-amine, tri-methyl-amine, ethyl-amine, propyl-amine, aniline, and nicotine. All the bases of the first group expel almost completely the bases of the second group from their salts in dilute solutions. The same fact has been already observed with acids. Both the strong acids and the strong bases when dissolved in water produce the normal molecular lowering of the congelation-point, bordering on 40, whilst feeble acids and bases produce merely an abnormal lowering of about 20.

Determination of the Equivalent of Nickel by Means of its Sulphate.—H. Baubigny.—Will be inserted in full.

Volumetric Determination of Iron by Means of a Solution of Sodium Hyposulphite and Sodium Salicylate.—G. Bruel.—This process is of great sensibility, being accurate to one-half milligram. As compared with the process of Margueritte it has the advantage of nullifying the disturbing action of the air, since the iron is operated upon in the state of a per-salt. The author takes 1 gram. of pure iron, dissolves it in 20 c.c. hydrochloric acid, adds to the solution a few crystals of potassium chlorate, dilutes with water, and boils until the odour of chlorine is no longer perceptible. He then makes the solution up to 1 litre with distilled water, thus obtaining a solution of ferric chloride containing 0.001 gram. of iron per c.c. He then prepares a solution containing 1.0000 sodium hyposulphite in distilled water. He takes 10 c.c. of the ferric solution, puts it in a flask, adds four times its volume of distilled water, and raises the solution to a boil after having added 0.10 gram. sodium salicylate. The solution of hyposulphite contained in a Gay-Lussac burette, graduated to tenths of a c.c., is then poured drop by drop into the ferric solution, which becomes gradually decolourised. When the liquid presents merely a rose tint, scarcely appreciable, the burette is read off. When the solution of hyposulphite is thus standardised we may determine either the total iron present in a salt or in an ore, or the per-salt present in a partially oxidised proto-salt or in any salt of iron.

Detection of Blood upon Garments which have been Washed.—C. Husson.—When linen stained with blood has been thoroughly washed it is difficult to detect the characteristic elements. When the microscope and the spectroscope have detected neither hæmoglobine nor hæmatine, it would be imprudent to reckon upon the discovery of fibrine. But it may be important to show the care which the accused has taken to wash one part of a garment more than another. Water does not generally suffice to remove every trace of blood; the spot requires to be soaped, and when it is not afterwards rinsed with abundance of water, the linen or the garment generally retains traces of soap, which may be recognised without interfering with the search for crystals of hæmatine hydrochlorate. The author, having cut off a portion of the tissue at the suspected part, puts it in a watch-glass, and moistens it with a few drops of distilled water. The whole is kept for two hours on the sand-bath at about 40°, a drop of water being occasionally added to prevent drying up. The swatch is then pressed with small forceps, and the liquid which flows out indicates by its colour if crystals of hæmatine may be expected. This water is evaporated drop by drop on a slip of glass which serves for microscopic observation. If the liquid is too much spread out upon the glass, the residue is scraped and carefully brought to the centre of the slip, where it is retained by means of a drop of a solution of potassium iodide or chloride at 1.0000. The same portion of the tissue is put back in the watch-glass, and treated with a small quantity of glacial acetic acid, which, after being pressed out, is evaporated upon the first residue with the precautions laid down above. Having placed a disc of thin glass upon the residue glacial acetic acid is introduced by capillarity between the two glasses. It is heated to boiling and let cool, care being taken to slope the glass slip slightly so that the liquid which has not evaporated may collect at one of the angles of the thin glass cover. If there is still hæmatine the crystals of the hydrochlorate will appear. If there is soap, we find yellow drops of oleic acid along with margaric acid, which crystallises in characteristic needles, more or less curved. They appear first in the form of an elongated C. If there is much soap these needles unite, and form hairy dendriform masses. If there is but little they unite two by two, or in small fibrous tufts, which have a certain resemblance to fibrine fixed upon the fragments of the tissue. This similitude of form, though remote, may mislead. Filaments of fibrine, seen with the microscope without crystals or rays of hæmatine, do not seem a sufficient proof of the presence

of blood. When the washed spot is large enough a second portion may be cut off, boiled in distilled water, the liquid filtered through a very small filter, evaporated down, and ignited in a platinum capsule. The residue is taken up in a drop of distilled water, which turns the edge of a slip of red litmus paper blue. Both the acid and the alkali of the soap are thus demonstrated.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin.
Vol. 16, No. 4.

The Magnetic Property of Platinum Ore.—Theodor Wilm.—The magnetic property of platinum ores varies greatly, and has little relation to the proportion of iron present. Experiment has shown that a purification of platinum ores with the magnet has no practical value, the non-magnetic portion being little richer in platinum than the more highly magnetic parts. To detect the intentional adulteration of platinum ores with iron filings, the author recommends treatment with pure hydrochloric acid at a gentle heat. With a genuine ore there is no evolution of gas, whilst with falsified samples there sets in a regular escape of hydrogen in bubbles.

Nitro-derivatives of Resorcin.—R. Benedikt.—The author points out certain omissions in P. G. W. Typke's paper (*Berichte*, xvi., 551).

Behaviour of Mono-nitranilines with the Chinolin Reaction.—W. La Coste.—Not capable of useful abridgment.

Cinnoline Derivatives.—V. von Richter.—The author gives the name cinnoline to a group of bodies, which may be viewed as chinoline, where the CH group, united with oxygen, is replaced by an atom of nitrogen. He describes at length oxy-cinnoline-carbonic acid, oxy-cinnoline, and cinnoline.

β -Naphtho-cumarine.—G. Kaufmann.—Naphtho-cumarine, $C_{13}H_8O_2$, is readily soluble in acetic acid, alcohol, ether, and chloroform; sparingly in hot water. It crystallises in vitreous felted needles, and melts at 118° . The aqueous solution displays a bluish fluorescence.

Sulpho Acids of Hydroquinone.—A. Seyda.—An examination of mono-, di-, and hydro-quinonic acids, with their principal salts.

Nitro-, Amido-, and Oxy-Methyl-anthraquinone.—H. Römer and W. Link.—A description in detail of nitro-methyl-anthraquinone, of amido-methyl-anthraquinone, acetyl-amido-methyl-anthraquinone, oxy-methyl-anthraquinone, and acetyl-oxy-methyl-anthraquinone.

Amido-methyl-anthranol.—H. Römer and W. Link.—An account of acetyl-amido-methyl-anthranol.

Violet Derivatives of Tri-phenyl-methan.—O. Fischer and L. German.—The authors examine and reject the view of E. and O. Fischer, that methyl-violet is to be regarded as a penta-methyl-para-rosaniline. According to their researches it contains six methyl groups, and on its conversion into methyl-green there occurs a perfectly normal quaternary formation of ammonium.

New Formation of Skatol.—O. Fischer and L. German.—The authors mix 100 grms. aniline carefully with from 70 to 80 zinc chloride, and heat in the oil-bath with 100 grms. glycerin to from 160° to 170° , afterwards to 240° . After this temperature has been maintained for two hours, it is acidified with very dilute sulphuric acid, and mixed with the distillate which has passed over. A current of steam is then passed through the liquid, and carries along with it an oil, from which the authors have separated skatol.

Oxy-quinoline Derivatives.—Otto Fischer.—The author gives a description of α -oxy-quinoline-tetra-hydrate, α -oxy-hydro-methyl-quinoline, its hydrochlorate, known also as kairine, its sulphate, and picrate; oxy-hydro-ethyl-quinoline, the derivatives of ethoxy-quinoline, and its action upon the animal organism.

β -Oxy-quinoline.—C. Riemerschmied.—This memoir does not admit of useful abstraction.

A Correction.—L. Limpach.—The author corrects an error in the specification of Levinstein's patent for preparing the tri-sulpho-acid of β -naphthol.

Explanation on a Memoir on a Condensation-Product of Phenanthren-quinone and Acetacetic Ether.—F. R. Japp and F. W. Streatfield.—The authors complain of mistranslations in their memoir (*Berichte*, xvi., p. 462), and refer to the original in the *Journal of the Chemical Society*.

Tetra-hydro-quinoline.—L. Hoffmann and W. Königs.—The author gives an account of tetra-hydro-quinoline, its nitroso-compound, hydrazine, and tetrazone; its methylation, tetra-hydro-quinoline urea, benzoyl, and acetyl-tetra-hydro-quinoline; the oxidation of tetra-hydro-quinoline; its behaviour with sulphuric and nitric acids; with bromine; its behaviour at a red-heat, and the physiological effect of the hydridised derivatives of pyridine.

Aromatic Hydantoines.—A. Ehrlich.—The author has obtained ortho-toluy-hydantoine and toluy-hydantoinic acid.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Steatite.—Can you inform us for what purpose steatite is used. An article appeared in a paper lately about it saying that a new and very extensive use had been found for it, but our informant could not give us any particulars as to what paper he saw it in. It will be a great favour, therefore, if you can give us any information regarding it.—J. H. T.

MEETINGS FOR THE WEEK

MONDAY Nov. 26th.—Medical, 8.30.
TUESDAY, 27th.—Institute of Civil Engineers, 8.
Royal Medical and Chirurgical, 8.30.
WEDNESDAY, 28th.—Society of Arts, 8.
FRIDAY, 30th.—Royal, 4. (Anniversary.)

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CONTENTS.

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3. Science and Savants in Modern Literature.
4. On the Origin of the Cells of the Hive Bee.
5. "Progress" from an Evolutionist Point of View. By Frank Fernseed.
6. Our Animal Enemies and Allies Reconsidered.
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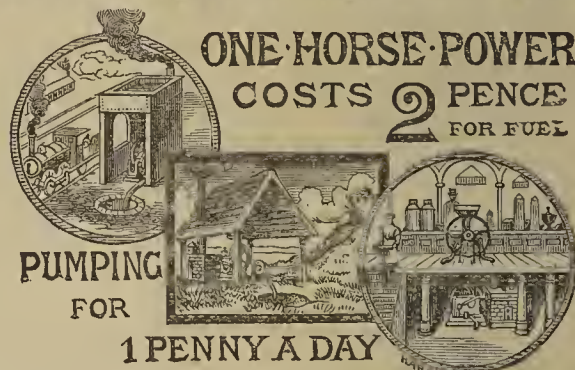
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THE CHEMICAL NEWS.

VOL. XLVIII. No. 1253.

ON THE PRESSURE OF THE VAPOUR OF MERCURY AT THE ORDINARY TEMPERATURE.*

By Professor McLEOD.

At the last meeting of the Association Lord Rayleigh called attention to a paper that had appeared in the *Annalen der Physik und Chemie* (N.F., xvi., 610), by Hagen, on the pressure of saturated mercury vapour at low temperatures. The pressures given for the ordinary atmospheric temperatures, although considerably less than those published by Regnault, appeared rather higher than some recent observations seemed to warrant. A method of determining the vapour pressure at ordinary temperatures seems to have occurred to Mr. Crookes and myself almost simultaneously, and I much regret that his absence from the present meeting prevents us from learning the results of his work. Mr. Crookes intended to try the experiment *in vacuo*, whereas I thought of saturating air with mercury vapour; but we both intended to determine the quantity of evaporated mercury by a chemical test.

A glass flask of about 1.9 litres capacity was employed for the experiment, and within it was supported, by a piece of string, a glass tube 14 m.m. in diameter, and filled with freshly-distilled mercury, the flask being closed by a greased glass plate. After standing at the temperature of the laboratory for about nine days, the mercury tube was removed, and a small quantity of boiling nitric acid poured into the flask and left to stand for some time. The acid was next neutralised by ammonia, and after the fumes in the flask had disappeared, the liquid was washed out with water, acidulated with hydrochloric acid, and treated with sulphuretted hydrogen. A slight brown colouration resulted. Several standard solutions of mercury were then made, and tested with sulphuretted hydrogen in the same manner. The liquid from the flask gave a deeper colour than the solution containing 0.00006 gm. of mercury, and a lighter colour than that containing 0.00012 gm. It may therefore be assumed that the flask contained about 0.00009 gm. of mercury vapour.

Subsequently the same flask was used, and a tube of mercury 24 m.m. in diameter (or exposing nearly three times as much mercury surface as the first) suspended in it, and allowed to stand for a month. Treated in a similar manner, the colour was nearly the same (a little lighter if anything) as that produced by a solution containing 0.00012 gm. of mercury. One litre of the air in the flask therefore contained—

$$\frac{0.00012}{1.9} = 0.00006316 \text{ gm. mercury.}$$

As the theoretical weight of a litre of mercury vapour at 20° C. and the normal pressure is 8.3474 grms., the volume of the vapour in 1 litre of the air was—

$$\frac{0.00006316 \times 1000}{8.3474} = 0.007566 \text{ c.c.,}$$

or $\frac{1}{132160}$ of the total volume. The pressure of the mercury vapour was therefore—

$$\frac{760}{132160} = 0.00574 \text{ m.m.,}$$

whereas Hagen's number for 20° is 0.021 m.m.

It may be observed that this method might have been expected to give rather an excess than a defect of the quantity of mercury, in consequence of condensation of

mercury on the sides of the flask, and although the experiment was of a somewhat rough character, it seems to show that Hagen's number is too high.

A paper has also been published by Hertz (*Ann. Phys. u. Chem.*, N.F., xvii., 193), in which he estimates the pressure of the vapour at 20° to be only 0.0013, or only about one-fifth as great as indicated by the foregoing experiments.

METHOD FOR PREPARING URANIC NITRATE OR ACETATE FROM THE RESIDUES.

By J. T. SAVORY, F.I.C.

THE precipitate of uranyl phosphate, or uranyl ammonium phosphate, is washed by decantation until free from soluble salts. It is now dried, powdered, and ignited to expel ammonia from the double phosphate. The resulting uranyl phosphate is then dissolved with the aid of heat in pure strong nitric acid, and while the solution is still on the water-bath, pure, coarsely-granulated tin is added in small portions, in quantity equal to one-half the weight of the phosphate. When the action has ceased the mass is evaporated to dryness, and gently heated on a sand-bath. The stannic oxide containing *all* the phosphoric acid is then broken up, and boiled out with successive portions of nitric acid (one in four), allowing to settle after each treatment, and filtering through Swedish paper. The solution of uranyl nitrate is then concentrated, and the salt crystallised out, and drained on a porous tile. Recrystallisation is generally unnecessary.

If the acetate be required, the solution of the nitrate is evaporated to dryness, and gently heated till acid vapours are no longer given off, and the remaining uranyl oxide, which should be yellowish red if not too strongly heated, is dissolved in warm acetic acid, filtered, and the acetate crystallised out as in Wertheim's method.

It is important that the tin used should be pure and also not too finely divided. If the powdered metal be used the action is very violent, and portions of it are fused, and even become incandescent and cause spitting. The stannic oxide produced, too, will be difficult to filter, being very finely divided. If the acid used be not heated, or too dilute, stannic salt may be produced, which, by slowly decomposing, would make the solution turbid.

This method gives a yield of over 90 per cent, and is less troublesome than that of Reichard.

Laboratory of the Royal Agricultural Society,
November 22, 1883.

ON THE ATOMIC WEIGHT OF TITANIUM.*

By T. E. THORPE F.R.S.

THE stoichiometrical quantities which we ordinarily term atomic weights are not only the fundamental constants of chemical calculations; their relations as mere numbers are of the highest significance in connexion with our conceptions concerning the essential nature of matter.

The recent publications of Becker and Clarke in America, and of Dr. Lothar Meyer and Seubert in Germany, have served to demonstrate on how slight an experimental basis a large number—the greater proportion, it must be confessed—of the accepted values of these constants really depend.

A notable instance of this fact is seen in the case of titanium. The atomic weight of this element was determined by Rose in 1829, and by Pierre in 1847, with the following results:—

Rose	..	..	..	..	48.13 and 49.58
Pierre	..	..	..	..	50.25

* Read before the British Association, Southport Meeting.

* A Paper read before the Royal Society, November 22, 1883.

The commonly accepted value of titanium is that founded upon the experiments of Pierre; the atomic weight adopted by Mendelejeff in the series based upon his periodic law is 48, a number which finds some experimental support from the observations of Rose. The direct evidence in favour of either value is, however, very slight, and a critical examination of the observations affords no ground for assuming that Rose's value is nearer the truth than that of Pierre. It is probable that the value 48 has been adopted in one or two modern text-books, mainly because it agrees best with the requirements of the periodic law.

I have attempted to deduce the atomic weight of titanium from observations made with the tetrachloride, the tetrabromide, and the dioxide. The present communication contains the results furnished by the analysis of the chloride. The work with this body affords three independent values for Ti based on the ratios—

I.	.. .. .	TiCl ₄ : 4Ag
II.	.. .. .	TiCl ₄ : 4AgCl
III.	.. .. .	TiCl ₄ : TiO ₂

Series I.—TiCl₄ : 4Ag.

Weighed quantities of the tetrachloride were decomposed by water in closed vessels, and the chlorine precipitated by silver after the method of Gay-Lussac as modified by Stas—

	Chloride taken.	Silver employed.	Ti(H=1).
I.	.. .. 2'43275	5'52797	48'06
II.	.. .. 5'42332	12'32260	48'07
III.	.. .. 3'59601	8'17461	47'99
IV.	.. .. 3'31222	7'52721	48'05
V.	.. .. 4'20093	9'54679	48'05
VI.	.. .. 5'68888	12'92686	48'06
VII.	.. .. 5'65346	12'85490	47'95
VIII.	.. .. 4'08247	9'28305	47'94
	34'39004	78'16399	48'021

Series II.—TiCl₄ : 4AgCl.

Weighed portions of the tetrachloride after decomposition with water were treated with excess of silver nitrate, and the silver chloride separated by reverse filtration and weighed:—

	Chloride taken.	Silver Chloride.	Ti(H=1).
IX.	.. .. 3'31222	10'00235	47'99
X.	.. .. 4'20093	12'68762	47'98
XI.	.. .. 5'68888	17'17842	48'00
XII.	.. .. 5'65346	17'06703	48'06
XIII.	.. .. 4'08247	12'32442	48'06
	22'93796	69'25983	48'018

The total amount of the silver chloride thus obtained was 69'25983 grms. : it was formed from 53'13881 grms. of silver added in the preceding series. The weight of the silver chloride thus obtained from a known weight of silver and of titanium tetrachloride, not only affords an additional value for Ti, but it also serves as a rigorous check on the accuracy of the work, for if the ratio of Ag to AgCl turns out to be the same as that obtained by the direct union of chlorine and silver, it at once disposes of the possibility of error due to the co-precipitation of titanic acid, and is a guarantee of the purity of the silver employed—

Now $52'13881 : 69'25983 = \text{Ag} : \text{AgCl} = 1 : 1'3284$.

Stas found from seven experiments in which, in the aggregate, 969'3548 grms. of silver were found to give 1287'7420 grms. of silver chloride, that—

$\text{Ag} : \text{AgCl} = 1 : 1'32845$.

The two ratios, it will be seen, are almost identical.

Series III.—TiCl₄ : TiO₂.

The tetrachloride was decomposed by water, and the solution evaporated to dryness and strongly heated.

	Chloride taken.	Titanic Oxide.	Ti(H=1).
XIV.	.. .. 6'23398	2'62825	47'93
XV.	.. .. 8'96938	3'78335	48'00
XVI.	.. .. 10'19853	4'30128	47'95
XVII.	.. .. 6'56894	2'77011	47'96
XVIII.	.. .. 8'99981	3'79575	47'98
XIX.	.. .. 8'32885	3'51158	47'94
	49'29948	20'79032	47'970

All the experiments which were made, either for the estimation of the chlorine or the titanic oxide, are given with the exception of two; one of these was made upon a small quantity of material, and was considered as merely preliminary; the other miscarried, and was not persevered with.

In order to enable an opinion to be formed as to the agreement among the several observations, I have calculated the value of Ti afforded by each experiment. But probably the most accurate values of Ti would be deduced from the aggregate weights of the tetrachloride, silver, silver chloride, and titanic oxide, respectively. Inasmuch as it may be presumed that the employment of large quantities of material would tend to increase the accuracy of the result, by calculating the final values from the aggregate weights instead of merely taking the means of the several observations, the influence of the larger quantities is directly felt.

Assuming with Lothar Meyer and Seubert that the most probable ratios of Ag, Cl, O, and H are as follows—

Ag = 6'7456
Cl = 2'21586
O = 1
H = 0'06265

the various experiments afford the following values for Ti:—

I.	TiCl ₄ : 4Ag	= 34'39004 : 78'16399
		= 1'75989 : 4
	TiCl ₄ : O	= 11'8715 : 1
	Ti : O	= 3'0081 : 1
	Ti : H	= 48'014 : 1
II.	TiCl ₄ : 4AgCl	= 22'93796 : 69'25983
		= 1'32475 : 4
	TiCl ₄ : O	= 11'8716 : 1
	Ti : O	= 3'0082 : 1
	Ti : H	= 48'016 : 1
III.	TiCl ₄ : TiO ₂	= 49'29948 : 20'79032
		= 2'37124 : 1
	Ti : O	= 3'0053 : 1
	Ti : H	= 47'969 : 1

On the assumption that these values have equal weight, the final value becomes—

I. 48'014
II. 48'016
III. 47'969

Ti = 48'000

It would appear, therefore, from these observations that titanium must be added to the increasing list of the elements whose atomic weights are simple multiples of that of hydrogen.

In these observations, which have occupied me many months, I have sought to eliminate such sources of error as were known to me. It is of course possible, in spite of the agreement between the several values, that the results may be affected by undetected and constant errors. Experience warns us that no determination of atomic weight, however well the individual observations may agree among themselves, can be considered wholly satisfactory

if it depends upon a single reaction or is referred to a single relation. It is for this reason that I have sought to extend my observations to other compounds of titanium, and to vary the nature of the reactions involved in the chemical processes. Unfortunately, it is found that comparatively few bodies containing titanium lend themselves to the purpose of atomic weight determination. I am, however, making observations with the tetrabromide, which, in some respects, is to be preferred to the tetrachloride, and the results furnished by its analysis will be given in a second communication, which will also contain details respecting the preparation of the substances used, the methods of weighing, the processes of manipulation, effect of errors, &c. With reference to the tetrabromide, I may here say that I find it can be very easily made by the action of hydrobromic acid gas upon the chloride, and that this proves to be a more convenient method of preparation than that by which it was first obtained by Duppa.

ELECTRO-CHEMICAL RESEARCHES ON NITROGEN.

By GEORGE STILLINGFLEET JOHNSON.

IN November, 1881, a paper of mine was read before the Royal Society, entitled, "On Allotropic or Active Nitrogen, and on the Complete Synthesis of Ammonia." In that paper, which has not been published, were recorded the results of a series of experiments which had at that time led me to believe in the duality of nitrogen, a belief which has been confirmed by subsequent investigation.

At the time when my paper was read before the Royal Society, I was not aware of the investigations of M. H. Sainte-Claire Deville in this field (*vide Comptes Rendus*, 1865, lx., pp. 324 and 325). He demonstrated that the dissociation of ammonia gas by the spark was never complete.

I observed, in 1881, as I believe for the first time, that a mixture of pure nitrogen and hydrogen gases, in a perfectly dry state, and confined, either over pure sulphuric acid or over mercury in presence of charcoal, and in the requisite proportions to form ammonia, may be completely converted into that gas by a series of electric sparks; the ammonia being absorbed by the charcoal in the one case and by the acid in the other. Deville confined himself to effecting the complete conversion by a series of electric sparks of a mixture of nitrogen gas with three times its volume of hydrogen gas, and twice its volume of hydrochloric acid gas, into *sal-ammoniac*, but he did not demonstrate the synthesis of ammonia by passing the spark through pure $N + H_3$ gases in presence of an absorbent, such as charcoal or H_2SO_4 , incapable of yielding any vapour which might mingle with those gases, and thus modify the result. Nevertheless, this experiment of Deville's approached as near as possible to a demonstration of the possibility of synthesising ammonia by the electric spark, though it left the explanation of the incomplete dissociation of ammonia by that agent still obscure, inasmuch as, until the formation of NH_3 by the action of a series of electric sparks upon pure $N + H_3$ gases was absolutely proved, two hypotheses would still account for the small residual trace of ammonia left after the experiment, viz. (1st), incomplete decomposition, and (2nd) complete decomposition in the first place, followed by recombination of a portion of the gases.

Now, since I have shown that when the spark is passed through pure $N + H_3$ gases in the *absence* of any absorbent for ammonia, as when the gases stand over mercury *e.g.*, a small quantity of ammonia only is produced, which never accumulates, it is clear that both these causes operate; synthesis first takes place, and as soon as the ammonia gas reaches a certain tension in the mixture, dissociation occurs as fast as ammonia is produced.

In the course of my work, recorded in November, 1881,

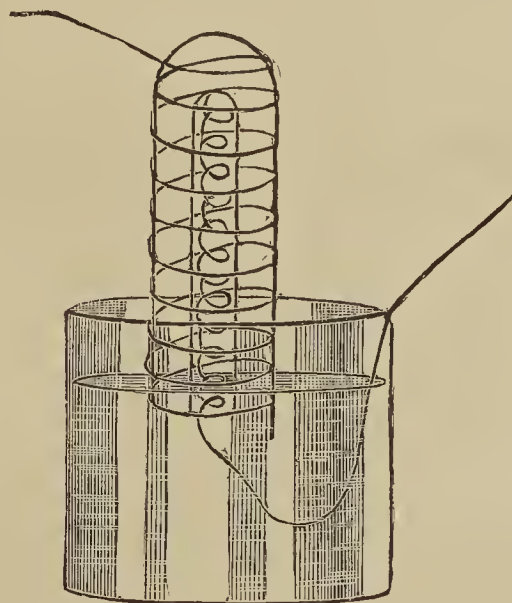
I endeavoured to accumulate active nitrogen by means of the effluve, or silent discharge.

Prolonged Action of the Effluve upon Nitrogen and Hydrogen.

It is known that oxygen is rendered active by this agent, the gas becoming converted into ozone, which is generally regarded as $-O_2$ combined with $+O$. Now, as the distinguishing feature of active nitrogen appears to be the comparative readiness with which it combines with hydrogen to form ammonia, and as we may presume the N in ammonia to be electro-negative, we naturally turn to the effluve as the agent most likely to produce this allotropic nitrogen in quantity. In my first experiments, recorded November, 1881, I failed in this endeavour, for reasons which will become obvious on considering the following observations:—

Having incidentally discovered that a mixture of hydrogen and oxygen gases in proportions $H_2 + O$ may be exploded without the agency of sparks by a current of electricity passed round the glass vessel containing them, a result which has been since this confirmed by MM. Déherain and Maquenne in a paper published by them in the *Comptes Rendus*, I proceeded to make some further experiments with mixtures of H and O in other proportions submitted to the same influence. The apparatus employed consisted of two tubes, each closed at one end and open at the other, and fitting loosely the one into the other, the space left between them being occupied by the gases under observation. These gases were confined in the tubes by water, in which the open ends of the tubes were immersed. Coils of copper wire were twined round the exterior of the outer tube and the interior of the inner one, these two coils being separated from one another by the glass walls of the two tubes, and connected with a Ruhmkorff coil capable of giving a two-inch spark in the air, and fed by four Groves cells. (Fig. 1.)

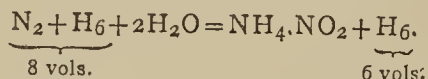
FIG. 1.



It was observed that when the explosive mixture between the walls of the two tubes was diluted largely by either of the ingredients, a perceptible time elapsed before explosion occurred under the influence of the effluve. On some occasions explosion occurred at last after the electricity had traversed the tubes for a period of from one to two hours.

Guided by these results, I determined to submit a mixture of nitrogen and hydrogen gases to the *prolonged* action of the effluve in the apparatus figured above, knowing that it would be useless to attempt to accumulate active nitrogen by an agent, or in an apparatus in which combination between nitrogen and hydrogen gases could not be effected. Accordingly, a mixture of atmospheric

air and a little more hydrogen than necessary to combine with the whole of the oxygen present was exploded over water, and pure hydrogen added to the residual gas till the proportion $N+H_3$ had been reached. 45 c.c. of this mixture was introduced between the two glass tubes described and figured above, and the effluve was passed through the gases for a number of hours, the confining liquid being water faintly acidulated with sulphuric acid and coloured red by solution of litmus. Very slow and gradual contraction took place. After fifty hours, the volume of the gas was reduced to 27 c.c., showing a contraction of 13 c.c., yet was the liquid even in the tube quite red, showing the absence of free ammonia. This result, which was verified again and again, caused much surprise, but light is thrown upon it by the recent observation of MM. Déherain and Maquenne that the vapour of water is dissociated under certain conditions by the effluve, which suggests the following explanation of the reaction:—



And this is confirmed by the observation of MM. P. and A. Thénard (*Comptes Rendus*, lxxxvi., 517, 1508), that nitrogen gas, subjected to the influence of the effluve in presence of aqueous vapour, disappears, and forms a body which appears to be *ammonium nitrite*.

From my experiments just cited, it seems that even in presence of hydrogen in sufficient quantity to form ammonia by combination with it, nitrogen gas in presence of aqueous vapour and under the influence of the effluve, will, under certain conditions, yield no free ammonia, but ammonium nitrite.

Berthelot has confirmed the experiments of Thénard as regards the action of the effluve upon a mixture of nitrogen gas and aqueous vapour. Berthelot finds (*Bull. Soc. Chim.*, [2], xxvii., 338) that ammonium nitrite is formed when perfectly pure nitrogen gas and water are enclosed between two concentric tubes and subjected to the action of a powerful Rhumkorff's coil.

The following experiment, however, shows the influence of tension of the electric current in modifying the results obtained:—

The same apparatus, the same gases, and the same electrical arrangements were employed as in the experiments last recorded, the only difference being that the tubes were gently warmed by a burner placed in their vicinity just sufficiently to keep the glass dry. The contraction became at once much more rapid, and free ammonia was formed as shown by the blueing of the litmus in the liquid as it rose up the tube.

To ascertain whether the heat applied had any action in causing combination, other than in drying the glass, I performed a perfectly similar experiment to the above, substituting oil of vitriol for the water as the confining and absorbing liquid, so that the walls of the tubes were kept dry without any application of heat at all. Contraction took place as rapidly as before on passing the effluve through the dry gases. In this connection, I must quote the experiments of Berthelot (*Comptes Rendus*, lxxxii., 1283, 1360), who has shown that when nitrogen and hydrogen combine under the influence of the effluve, not more than 3 per cent of the gases ever combine to form ammonia, unless some absorbent be present to remove it as it is produced.

The points of interest in my experiments are (1) they indicate that electricity of a higher tension is required to cause combination between N and H to form ammonia, than is necessary to the production of ammonium nitrite by the union of N, H, and O^* ; and (2) they confirm the

* This seems to be the only possible explanation of the different effect observed when the effluve is passed through $N+H_3$ gases in presence of aqueous vapour, first, in a moist glass envelope, and, secondly, in a dry one, the moist glass in the first case causing loss of electricity by conduction down the tube into the acidulated water, and thus diminishing the tension of the electricity left free to act upon the confined gas.

results of MM. Thénard and Berthelot regarding the action of the effluve upon nitrogen gas in presence of aqueous vapour, and thus prove the absolute necessity of ensuring the perfect dryness of nitrogen gas which we attempt to render active by the silent discharge. I may add that my failure to accumulate active nitrogen in my first experiments is accounted for by the fact that no special precautions were taken to render the gas thoroughly dry before its entrance into the induction-tube, so that the aqueous vapour present in the gas prevented the possibility of the formation of free electro-negative N, ammonium nitrite being found instead. The only statement in my paper of 1881 which I wish to modify is this, that "nitrogen gas is not rendered active by the effluve," and the modification I would introduce is the following, unless the gas be perfectly dry and the electricity of high tension:—

Behaviour of Nitrogen and Hydrogen Gases in Grove's Gas Battery.

I was induced to investigate the behaviour of nitrogen and hydrogen gases in Grove's gas battery in the expectation that by virtue of the so-called "polarisation" of the platinum plates known to occur in that apparatus, the nitrogen might receive an excess of electro-negativity, and be thus rendered capable of combining with hydrogen to form ammonia.

The apparatus employed consisted of a series of four cells, each provided with two tubes of glass 10 inches in length and half an inch in diameter. Platinum wires of good thickness were fused into the closed ends of these tubes in the usual way, and soldered below on to platinum plates nearly as wide as the tubes; varying from $8\frac{1}{2}$ to 9 inches in length, and thickly covered with electro-deposited platinum (platinised).

Method of Experimentation.

The liquid under experiment having been introduced into the cell and the tubes filled with it by inverting the cell as usual, pure hydrogen was introduced into each cell by displacement in the usual way and left till no current showed itself on making contact with the galvanometer. This precaution was taken in order to remove all occluded oxygen from the platinum plates. The liquid was then again introduced into the tubes by simply inverting the cell as before. Into one of the tubes pure nitrogen was then introduced. This was always effected in the same way, viz., by forcing air from bellows through potash and strong sulphuric acid, and then through a tube 22 inches in length, packed with freshly-reduced copper from copper oxide by hydrogen, a clip being attached to the india-rubber tube connecting the extremity of the copper tube with the glass delivery tube entering the acid of the cell, so as to regulate the stream till it became very slow, the air in the copper tube being consequently under pressure, which would assist the complete absorption of the oxygen by the heated metal. As soon as 1 inch of the reduced copper showed signs of oxidation, a stream of hydrogen was made to traverse the heated copper till reduction was again complete. The nitrogen having been introduced, its volume was marked off upon the tube (as soon as it had cooled), and pure hydrogen (purified by passing through solution of mercuric chloride) was then introduced into the opposite tube, and its volume also carefully marked. Contact was then made between the two tubes by metallic wire, and any contraction which might occur carefully observed.

Experiments showing the Influence of Acids of Different Strengths in the Cells upon the Amount of Contraction.

In the first experiment, conducted in the manner above described, four cells were charged with dilute sulphuric acid, no care being taken to ensure an equal strength of acid in each cell. Contact was made between the hydrogen and nitrogen plates of each cell alternately with its adjacent cell, when contraction began in one of the

hydrogen tubes, and after a great part of the gas had disappeared from that tube, the hydrogen in another cell was observed to be contracting. This was the first indication I received that the amount of contraction is influenced by the strength of the acid in the cell. I followed this up, till I discovered that the amount of contraction varies with the *conductivity* (electrical) of the acid in the cell; the most marked contraction, and also the strongest currents being produced with the acids of highest conducting power. For this reason I experimented usually with dilute sulphuric acid of specific gravity 1.220, that being the strength of acid which is possessed of most conducting power, according to the tables of Kohlrausch (*Pogg. Ann.*, cliv., 233). When hydrochloric acid was employed, it was used of specific gravity 1.100, acid of this strength being not only a better conductor than hydrochloric acid of any other strength, but even a slightly better conductor than sulphuric acid of specific gravity 1.220; according to Kohlrausch (*loc. cit.*), if the conductivity of dilute H_2SO_4 of sp. gr. 1.2207 be represented by the number 6912, that of dilute HCl of sp. gr. 1.1001 is represented as 7132.

Experiments showing the Influence of Varying Resistance to the Electric Current in the Metallic Wires employed for making Contact between the Platinum Plates in the two Tubes.

My first experiment with nitrogen and hydrogen in Grove's gas battery put me on my guard in respect to the strength of the acids in the cells. The second showed that the conductivity of the wires used for connecting the platinum plates together was of no less importance. In this case I was very careful that all the acids should be of equal strengths, but instead of making contact with *copper* wires as at first, I used thin platinum wires for this purpose. The result was a complete absence of contraction in *all the tubes*. But on making contact with the *same* platinum wire between the hydrogen and nitrogen plates in a *single* cell, the hydrogen in that cell began to contract at once, and the same with all the others in turn, though they had retained constant volumes for some days previously when connected alternately, the hydrogen of one cell with the nitrogen of the next. I subsequently discovered that if thick copper wires were used to connect the plates, contraction occurred in all the cells simultaneously when alternately connected.

Description of Experiments with Nitrogen and Hydrogen in Cells containing two Tubes each.

When the acid in the cell was dilute sulphuric (1 to 6 of water), contact being made between the hydrogen and nitrogen plates of the same cell with thin platinum wire, and 1 inch of each plate being immersed in the acid, in all cases the hydrogen *contracted*, whilst the nitrogen *increased* in volume. When two-thirds of the nitrogen plate was immersed in the acid, and only one-ninth of the hydrogen plate was in the same condition, the gases in both tubes contracted in the proportion 1 : 3, but *very slowly*.

After the hydrogen in a cell containing two tubes originally full of N and H, connected by thin platinum wire and immersed in the dilute sulphuric acid (1 to 6) had diminished in volume by one-half, the gas in the nitrogen tube, which had been continually expanding, and had therefore of necessity been two or three times partially expelled by inverting the cell, so as to keep its platinum plate in contact with the acid, was transferred to a graduated tube over mercury, mixed with a known volume of oxygen, and then subjected to the action of a piece of platinum sponge. By the contraction observed, the gas was found to contain 18 per cent of hydrogen.

In the above experiment, though the acid was a good conductor, the resistance offered by the wire was considerable, hence no evidence was observed of *combination* between the nitrogen and hydrogen; indeed, if any combination took place at all, it must have been extremely

small, since the *expansion* of the nitrogen appeared to be equal to the contraction of the hydrogen gas, *i.e.*, when both tubes were originally nearly full of N and H respectively. Even when the nitrogen had a smaller volume than the hydrogen, the contraction of the N first observed soon ceased and was followed by expansion.

The acid next employed was sulphuric acid of sp. gr. 1.37, which has a conductivity represented by the number 5500 (nearly) on Kohlrausch's scale.

When acid of this strength was introduced into a cell containing two tubes charged with pure nitrogen and hydrogen gas in the manner above described, the platinum plates being 10 inches in length, 4 inches of each being immersed in the acid, and contact being made with thick copper wire between the two plates, *both* gases contracted very slowly in proportions 1 N : 3 H. On making contact with a delicate galvanometer, a current was observed passing from the H plate to the N plate, which deflected the needle about 2° . This current, as in all cases with N and H in Grove's gas battery, ceased after a few seconds, but re-appeared on disconnecting for a minute or two, and then again making contact with the galvanometer. (N.B. The galvanometer employed possessed long coils of wire, and therefore must have offered considerable resistance.)

After *twenty-two* hours, the contraction of the hydrogen amounted to four-fifths of an inch, whilst the nitrogen had contracted one-fifth of an inch. The galvanometer still showed a deflection of 2° produced by a current passing from the hydrogen plate to the nitrogen one.

In my next experiment I employed dilute sulphuric acid of sp. gr. 1.184, whose conducting number would be about 6300, an acid of much better conductivity than the last. The platinum plates in this case were 9 inches long, and 2.2 inches thereof were immersed in the acid. On making connection by a short thick copper wire between the two plates, the hydrogen began to contract rapidly at once. The nitrogen at first retained a constant volume, afterwards slightly contracted, and subsequently *expanded*, the hydrogen still contracting, but more and more slowly.

A few minutes after making connection, whilst the hydrogen was rapidly contracting, connection was made with the galvanometer, when the needle was deflected 45° by a current passing from the H to the N plate.

After one hour, the deflection only amounted to 15° .

After *twenty* hours the hydrogen had undergone a total contraction of 1 and 4-5ths inches, whilst the nitrogen had expanded 3-5ths of an inch. The deflection of the galvanometer needle was now reduced to 6° .

It will be observed that in the above experiment the contraction of the hydrogen was *three times* as great as the expansion of the nitrogen, so that a large proportion of that gas must have combined; also that in addition to rapid contraction with (at all events) partial combination of the hydrogen with contents of the nitrogen tube, a much more powerful deflection of the needle of the galvanometer was produced by the plates immersed in acid of a better conducting power than in any hitherto employed.

Several experiments were now made with dilute H_2SO_4 , sp. gr. 1.220, conducting number 6912 (best conducting sulphuric acid). A cell with its two tubes having been charged with the acid in the usual way, the tubes were half filled with pure nitrogen and hydrogen gases respectively. Thick copper wire used as connection.

The hydrogen contracted rapidly, whilst the nitrogen at first very slightly contracted, then retained a constant volume, and finally began to expand.

After three-quarters of an hour, the current from H to N deflected the needle of the galvanometer 45° ;* the contraction of the hydrogen being at that time $1\frac{3}{4}$ inches. In two hours more the total contraction of the hydrogen amounted to $1\frac{2}{3}$ inches (nearly 2 inches), whilst the nitrogen had *increased* in volume only 1-6th of an inch.

* In an experiment with sulphuric acid of the same strength, in which contact was made with the galvanometer, *immediately* after introducing the gases, the deflection of the needle amounted to 95° .

Needle now deflected only 10° . Here it is at once obvious that much hydrogen must have entered into combination, presumably with nitrogen.

In the case of *sulphuric acid*, it would be difficult to prove the formation of ammonia in such small quantities and its accumulation in the liquid of the cell, and for this reason I now substituted dilute *hydrochloric acid* for the sulphuric acid, employing an acid of sp. gr. 1.1001, with the object of subsequently detecting the ammonia produced (if any) by mixing the acid of the cell with platinic chloride and evaporating, to estimate the NH_3 as $\text{PtCl}_4 \cdot 2\text{NH}_4\text{Cl}$ in the usual way.

The method of experimentation being unaltered in my first experiment with dilute HCl of sp. gr. 1.100, the phenomena were very similar to those noted in the case of dilute H_2SO_4 of sp. gr. 1.220. Thus, after eighteen hours, the hydrogen had contracted $\frac{1}{4}$ ths inches, whilst the nitrogen, which had at first retained a constant volume, but subsequently expanded as before, had increased in volume $\frac{7}{10}$ ths of an inch. Hence, in this experiment, more than half the hydrogen had disappeared altogether from view.

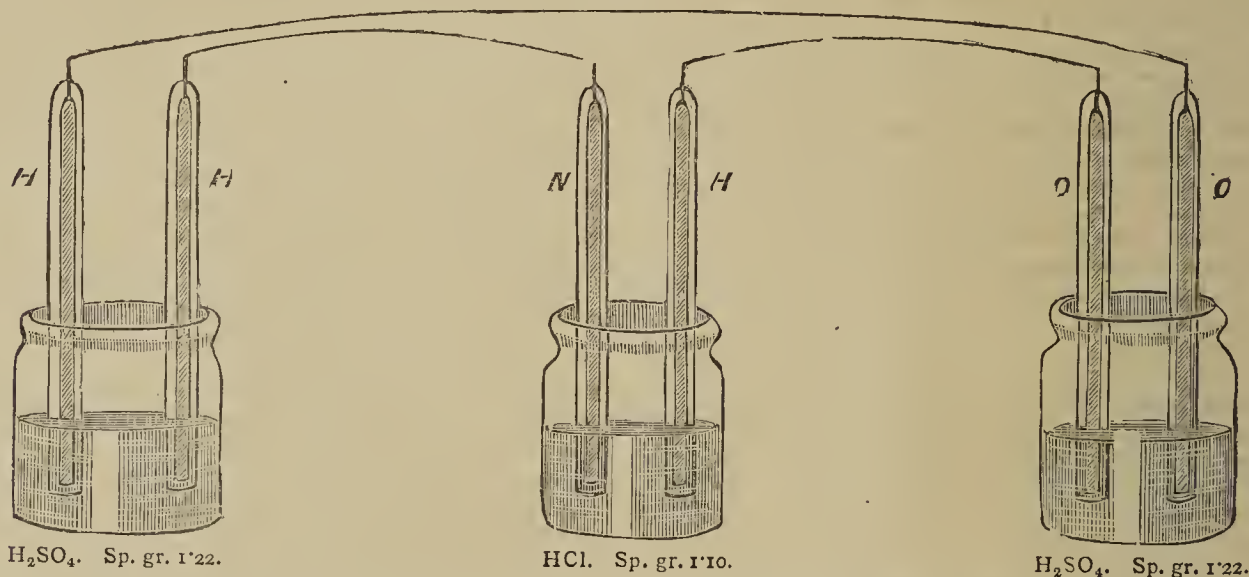
My next experiment was instituted with a view to determine whether the contraction of the hydrogen in contact with a platinum plate partially immersed in an acid of good conducting power, which I had invariably observed

undergone a *slight contraction*. This slight contraction of the nitrogen introduced into a tube containing a platinum plate previously charged with hydrogen gas I have frequently observed. In the tubes employed by me, which were $\frac{1}{2}$ inch in diameter, it never carried the liquid higher up the tube than 1-10th of an inch, and I attribute it to the combination of a portion of the nitrogen gas with hydrogen occluded in the platinum, and possibly to the subsequent occlusion of some of the nitrogen itself by the platinum.

Now, on breaking connection between the hydrogen plate of the central cell and the adjacent oxygen plate, and connecting it with the nitrogen plate of its own cell, the hydrogen gas in the central cell began to contract as usual. This result strengthens the idea that some chemical combination takes place between the nitrogen and hydrogen gases in Grove's gas battery.

When three cells, all containing acid of good conducting power, and each having two tubes filled with pure H and N respectively, were connected alternately, the H plate of one cell with the N plate of the next seriatim, all the hydrogens contracted, somewhat more rapidly than in a single cell, provided the connecting wires were short and thick, and of copper. The nitrogen usually contracted slightly at first, but soon ceased contracting, and began to expand after a few hours. The current produced on

FIG. 2.



when the hydrogenised plate was in contact with another one immersed in the same liquid and surrounded by nitrogen gas, was really due to some electro-chemical changes going on between the plates and the gases, or whether mere connection with another platinum plate would be sufficient to produce the disappearance of the hydrogen gas. This experiment was conducted as follows:—

One cell with a pair of tubes was charged with pure nitrogen and hydrogen gases, as above described. The liquid in this cell was dilute hydrochloric acid of sp. gr. 1.100. Two other cells, containing each dilute sulphuric acid, of sp. gr. 1.220, were charged, both tubes of the one with pure hydrogen gas, and both tubes of the other with pure oxygen. The cell containing HCl and nitrogen and hydrogen gases being placed between the other two cells, connection was made by thick copper wire between the nitrogen plate of the central cell and one of the hydrogen plates of the hydrogenised cell on the one hand, and between the hydrogen plate of the central cell and one of the oxygen plates of the oxygenated cell on the other. The remaining hydrogen and oxygen plates were then connected by similar wire, as in Fig. 2.

After leaving the several tubes with their respective plates connected, as above described and figured, for *twenty hours*, all the gases were found to be quite unaltered in volume with the exception of the nitrogen, which had

connecting the external H and N with the galvanometer was at first powerful, but soon ceased altogether, to reappear after breaking contact, and again establishing connection.

My next experiments were performed with the object of producing a more powerful polarisation of the nitrogen, if possible, by taking advantage of the current produced by H and O in Grove's gas battery.

I made one or two preliminary experiments with hydrogen and oxygen gases themselves in Grove's gas battery, which brought out some interesting analogies and differences between the behaviour of these gases and that of nitrogen and hydrogen when placed in similar circumstances.

Thus it soon became evident that the rapidity of contraction, and the strength of current produced by H and O are alike influenced by the conductivity of the acid in the cell, as is the case with H and N. In a cell filled with equal volumes of strong sulphuric acid and water, the contraction of H and O was very slow, and the deflection produced on first making contact with the galvanometer was only 3° . Permanent deflection 1° .

When the same gases were confined over dilute H_2SO_4 , of sp. gr. 1.22 (best conductor), however, not only was the contraction of the gases much more rapid, but also the first deflection amounted to 60° , whilst the needle was permanently deflected through an angle of 11° on leaving

the tubes in contact. As in the case of nitrogen and hydrogen, the current observed on first making contact with the galvanometer rapidly diminishes in force in the case of H and O, but with these gases a *permanent deflection* is observed on leaving the plates in contact with the galvanometer, which nitrogen and hydrogen seem to be incapable of producing.

To be continued.)

A TEST FOR TIN.

By CHARLES R. DRYER, M.D.

THE reaction between stannous chloride and a solution of brucia in nitric acid is well known to chemists; but, as far as the writer is aware, it has hitherto been used only for the detection of brucia and not as a test for tin. For the latter purpose it possesses several advantages over the ordinary test with mercuric chloride. It is more delicate, more striking, more convenient, and may be applied under conditions where the latter test cannot.

Brucine Reagent.—To 1 decigram. of crystallised brucia add 1 c.c. of pure nitric acid; when solution is complete, add 50 c.c. of water, heat to boiling, and cool. The heating is not necessary, but renders the reagent somewhat more sensitive. It is of a permanent orange-amber colour.

Use.—In the ordinary course of analysis the sulphides of arsenic, antimony, and tin are obtained upon a filter, and are digested with ammonium carbonate for the removal of arsenic. The residue is dissolved in strong hydrochloric acid, the solution evaporated, diluted with water, and a strip of platinum and a strip of zinc placed in it in contact for several hours. Nascent hydrogen reduces antimony chloride to metal, which is deposited upon the platinum, and stannic chloride to stannous chloride, which remains in solution. Now, if to a few drops of the brucine reagent in a white dish a drop of the solution containing stannous chloride be added, a distinct purple colour is produced.

Interference.—Neither zinc chloride nor nascent hydrogen produces any effect upon the reagent. Organic matter does not interfere. Ammonium sulphide and sodium hypsulphite act like stannous chloride.

Delicacy and Limits.—By using a solution of stannous chloride repeatedly diluted, it was found that a drop containing only 0.000025 grm. gave a distinct colour after about one minute. A drop containing 0.00002 grm. gave a barely perceptible cloudiness with mercuric chloride.

If the reagent be too dilute, the colour is pale and the reaction indistinct. If excess of brucia be used no purple colour is produced, but a dirty green or a decolouration resembling the morphia reaction.

Fort Wayne, Indiana, U.S.A.,
Nov. 1, 1883.

DETERMINATION OF THE ATOMIC WEIGHT OF NICKEL BY MEANS OF ITS SULPHATE.

By M. H. BAUBIGNY.

Preparation of the Sulphate.—The commercial nitrate is dissolved in ammonia mixed with a little ammonium carbonate, and the precipitate, especially the oxide of iron, is filtered off; then, having expelled the greater part of the ammonia by means of heat, the liquid is neutralised with sulphuric acid and the double sulphate which separates is collected. This salt, after being purified by several crystallisations, is finally transformed into nickel sulphate mixed with a little oxide by heating it to dull redness in an open muffle. If the pulverised product is treated with cold water, in which anhydrous nickel sulphate dissolves but slowly, the sulphates of copper and zinc dissolve in

great part if they still exist in appreciable quantity. In any case the last traces of these metals are entirely separated if we saturate in the cold with hydrogen sulphide the solution of nickel sulphate (operating at the end with the aid of boiling water) previously mixed with sufficient glacial acetic acid to hinder the precipitation of the nickel.

When the sulphides have been filtered off the solution is evaporated to dryness after being acidified with a little nitric acid to prevent the formation of nickel sulphide under the influence of heat. The sulphate is calcined and the oxide dissolved in nitric acid. If, according to Fischer's method, we then add a large excess of potassium acetate to sodium nitrite, the liquid, after eight to ten days, no longer contains a perceptible quantity of cobalt.

By combining this mode of separation with Langier's method, *i.e.*, crystallising in ammonia the nickel oxalate derived from the separated solution of the double cobalt and potassium nitrite, and evaporated with hydrochloric acid to decompose the excess of alkaline nitrite and acetate, the author has obtained nickel absolutely free from cobalt; at least the most careful analysis has not enabled him to find the slightest trace of cobalt. The oxalate is calcined, the resulting oxide is washed in water, taken up in sulphuric acid, and the sulphate is dried at 440°.

Lastly, as final purification, this nickel sulphate is converted into a crystalline sulphide in an acid liquid. For this purpose about 70 grms. of the sulphate are dissolved in a litre of water and saturated with sulphuretted hydrogen at the temperature of the atmosphere. The liquid is let settle for half an hour, the air being excluded, and the small quantity of sulphide formed is filtered off. The liquid which is slightly acidulated by the acid which has been set free is then heated to 100° in a closed vessel after having been again saturated with hydrogen sulphide. The nickel sulphide formed is absolutely pure, free from every other metal; it is dense, crystalline, and unalterable in the air. The mother-liquor, still rich in nickel, is decanted, evaporated to dryness to expel the bulk of the free acid, and the sulphate which remains yields a second portion of crystalline sulphide. These two sulphides then washed and dissolved, each separately in aqua-regia, furnish on evaporating their solutions with an excess of sulphuric acid the two sulphates which have served for the author's determinations. They were taken up in hot water, filtered, and allowed to crystallise.

Nickel sulphate retains energetically the last traces of free sulphuric acid, even at 440°. This is indicated by the sensible differences found for the equivalent when the action of heat has not been sufficiently prolonged. There is every reason to believe that this is due to a physical fact—to certain influences of capillarity not prevented by copper and zinc sulphates.

a. First Sulphate—To discover easily small losses of weight it was heated by periods of 12 hours until the weight was constant, the loss during this time not exceeding 1–2 milligrams. After 60 hours the weight no longer varied, and was found to be 6.2605 grms. It was calcined at the temperature of melting gold, with two repetitions for safety. There remained $\text{NiO} = 3.0225$ grms., and loss $(\text{SO}_3) = 3.238$ grms., whence the atomic weight $\text{Ni} = 29.372$ if $\text{S} = 16.037$, and $\text{Ni} = 29.337$ if $\text{S} = 16$.

b. On operating in the same manner with the second sulphate to a constant weight we have $\text{Ni} = 29.375$ if $\text{S} = 16.037$ and $\text{Ni} = 29.340$ if $\text{S} = 16$; for 4.4935 grms. of sulphate left 2.1695 grms. of nickel oxide. Whence the mean $\text{Ni} = 29.374$ if $\text{S} = 16.037$ and $\text{Ni} = 29.339$ if $\text{S} = 16$.

The oxide of nickel is very stable and does not become peroxidised by the action of the air. It is even known that the saline oxide Ni_3O_4 which the author made known in 1879 is transformed into protoxide by the action of heat. Further, the dissociation tension at the temperature of melting gold is null. This the author has demonstrated, since on heating 1.120 grm. of pure nickel oxide, obtained by the calcination of the sulphate, at the highest temperature of a reverberatory furnace, in an impervious

porcelain tube in which a barometric vacuum had been made, the depression of the mercurial column was null. The statements of Woehler, Liebig, and Laurent, as to the impossibility of decomposing nickel oxide by heat alone, are, therefore, correct.

The author insists upon this point on account of the error of some recent experimentalists who have supported the false notion of the decomposition of nickel oxide into metallic nickel and oxygen at a high temperature, confounding a phenomenon of reduction with one of dissociation, nickel oxide being already reduced at 270° in a reducing atmosphere. The experiment of Wenzell, who first announced this decomposition by heat alone, proves, in fact, absolutely nothing, since he calcined the oxide in an open crucible in the fire of a forge.

The determinations of the equivalent of nickel are numerous; but the results vary from 29 (according to Schneider, Sommaruga, and Lee, who employed complicated methods) to 29.5, the figure generally adopted at present, but in the author's opinion, too high. Erdmann and Marchand by reducing the oxide found about 29.3 and Russell 29.369.

The only attempt by means of the sulphate is due to M. Marignac, but deviations of from 29.2 to 29.5 hindered this *savant* from coming to a conclusion. The cause of this failure must be sought in the difficulty of preparing the normal sulphate.—*Comptes Rendus*.

DETERMINATION OF FREE FATTY ACIDS IN OILS.

By M. G. KRECHEL.

To detect qualitatively the presence of free fatty acids in an oil, the author employs a procedure the principle of which has been indicated by Jacobsen, and which consists in utilising the solubility of the salts of rosaniline in oils containing free fatty acids.

He first prepares a concentrated alcoholic solution of rosaniline acetate; he measures into a test-tube about 10 c.c. of the oil in question, adds to it 5 or 6 drops of the solution of rosaniline, agitates very strongly to ensure thorough mixture, heats in a boiling water-bath for 15 minutes to expel every trace of alcohol, lets settle for twelve hours, and filters. A rose colouration of the filtrate shows that the oil contains a free fatty acid.

The author has endeavoured to utilise these properties of the oils and the fatty acids for the determination of the latter, since a mere qualitative test renders but little service, especially when it is required to find the comparative value of several samples of a lubricating oil containing normally free fatty acids, such as olive oil.

After having ascertained that the power of an oil for dissolving rosaniline salts is proportional to the quantity of fatty acids present, he sought for a liquid which should be at once a good solvent of oils, but incapable of dissolving or decolourising rosaniline acetate. He finally selected rectified petroleum, which seemed to answer completely all the conditions required.

He also sought for an agent capable of altering the colour of the red liquid in a distinct manner, and proportionally to the rosaniline acetate in solution. He employs for this purpose "sulphuric petroleum," the preparation for which is indicated below.

The method of operation finally adopted is as follows:—

Ten c.c. of the oil in question are mixed in a test-tube with 1 c.c. of a concentrated alcoholic solution of rosaniline acetate. The liquids are strongly agitated to effect complete mixture, and the tube is then placed for an hour in a boiling water-bath in order to drive off the last trace of alcohol. It is then washed with rectified petroleum (spec. gr. 800, 0.800?) and the total volume is made up with this liquid to 100 c.c. Of this liquid 10 c.c. are

taken (more or less according to the intensity of the colouration) and diluted in a test-glass with rectified petroleum so as to make up 100 or 120 c.c. "Sulphuric petroleum" prepared as described below is then added drop by drop from a burette, until a distinct change of colour is effected.

The sulphuric petroleum used is thus prepared:—500 c.c. of rectified petroleum are mixed with 100–150 c.c. of sulphuric acid at sp. gr. 1.357. The mixture is stirred from time to time and allowed to react for at least ten days. There is formed a black deposit; the petroleum itself takes a dark colour, but after some time it clears again and gives off a strong odour of sulphurous acid, the action of which probably decolourises the solution of rosaniline acetate. It is decanted and filtered and is ready for use after its value has been established by titration, taking oleic acid as the standard of comparison. To this end a solution is made of 10 per cent oleic acid in an oil which contains no free fatty acid, which must be determined by a preliminary trial. The oils of colza and radish seed before purification are generally in this condition.

The oleic acid must be free from oleine and dissolve entirely in alcohol. This mixture is used for standardising the "sulphuric petroleum." We treat 10 c.c. of the solution of oleic acid in oil with rosaniline acetate; we filter and dilute, after washing as explained above and then standardise the "sulphuric petroleum."—*Journal de Pharmacie et de Chimie*.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.
Chief Chemist to the U.S. Geological Survey, Washington.

LITHIUM.

THE earlier determinations of the atomic weight of lithium by Arfvedson, Stromeyer, C. G. Gmelin, and Kralovanzky were all erroneous, because of the presence of sodium compounds in the material employed. The results of Berzelius, Hagen, and Hermann were also incorrect, and need no further notice here. The only investigations which we need to consider are those of Mallet, Diehl, Troost, and Stas.

Mallet's experiments† were conducted upon lithium chloride, which had been purified as completely as possible. In two trials the chloride was precipitated by nitrate of silver, which was collected upon a filter and estimated in the ordinary way. The figures in the third column represent the LiCl proportional to 100 parts of AgCl:—

7.1885 grms. LiCl gave	24.3086 grms. AgCl.	29.606
8.5947	" 29.0621 "	29.574

In a third experiment the LiCl was titrated with a standard solution of silver. 3.9942 grms. LiCl balanced 10.1702 grms. Ag, equivalent to 13.511 grms. AgCl. Hence $100 \text{ AgCl} = 29.593 \text{ LiCl}$. Mean of all three experiments, 29.581 ± 0.0087 .

Diehl,‡ whose paper begins with a good resumé of all the earlier determinations, describes experiments made with lithium carbonate. This salt, which was spectroscopically pure, was dried at 130° before weighing. It was then placed in an apparatus from which the carbon dioxide generated by the action of pure sulphuric acid upon it could be expelled, and the loss of weight determined. From this loss the following percentages of CO_2 in Li_2CO_3 were determined:—

* Smithsonian Miscellaneous Collections. "The Constants of Nature."

† *Silliman's Amer. Journal*, November, 1856. *Chem. Gazette*, 15, 7.

‡ *Ann. Chem. Pharm.*, 121, 93.

59'422
59'404
59'440
59'401

Mean 59'417 \pm 0'006

Diehl's investigation was quickly followed by a confirmation from Troost.* This chemist, in an earlier paper,† had sought to fix the atomic weight of lithium by an analysis of the sulphate, and had found a value not far from 6.5; thus confirming the results of Berzelius and of Hagen, who had employed the same method. But Diehl showed that the BaSO₄ precipitated from Li₂SO₄ always retained traces of Li, which were recognisable by spectral analysis, and which accounted for the error. In the later paper Troost made use of the chloride and the carbonate of lithium, both spectroscopically pure. The carbonate was strongly ignited with pure quartz powder, thus losing carbon dioxide, which loss was easily estimated. The subjoined results were obtained:—

0'970 grm. Li₂CO₃ lost 0'577 grm. CO₂. 59'485 per cent.
1'782 ,, 1'059 ,, 59'427

Mean 59'456 \pm 0'020

This combined with Diehl's mean, 59'417 \pm 0'006, gives a general mean of 59'420 \pm 0'0057.

The lithium chloride employed by Troost was heated in a stream of dry hydrochloric acid gas; of which the excess, after cooling, was expelled by a current of dry air. The salt was weighed in the same tube in which the foregoing operations had been performed, and the chlorine was then estimated as silver chloride. The usual ratio between LiCl and 100 parts of AgCl is given in the third column:—

1'309 grms. LiCl gave 4'420 grms. AgCl. 29'615
2'750 ,, 9'300 ,, 29'570

Mean 29'5925 \pm 0'0145

This combined with Mallet's mean, 29'581 \pm 0'0087, gives a general mean of 29'584 \pm 0'0075.

Finally, we come to the work of Stas,‡ which was executed with his usual wonderful accuracy. In three titrations, in which all the weights were reduced to a vacuum standard, the following quantities of LiCl balanced 100 parts of pure silver:—

39'356
39'357
39'361

Mean 39'358 \pm 0'001

In a second series of experiments, intended for determining the atomic weight of nitrogen, LiCl was converted into LiNO₃. The method was that employed for a similar purpose with the chlorides of sodium and of potassium. 100 parts of LiCl gave of LiNO₃:—

162'588
162'600
162'598

Mean 162'5953 \pm 0'0025

We have now the following ratios from which to deduce the atomic weight of lithium:—

- (1.) AgCl : LiCl :: 100 : 29'584 \pm 0'0075
- (2.) Ag : LiCl :: 100 : 39'358 0'001
- (3.) LiCl : LiNO₃ :: 100 : 162'5953 0'0025
- (4.) Per cent of CO₂ in Li₂CO₃ 59'420 0'0057

Hence two values for the molecular weight of LiCl:—

From (1) LiCl = 42'3187 \pm 0'0039
From (2) „ = 42'3787 0'0111

General mean .. „ = 42'3720 0'0037

For lithium itself we get three values:—

From molecular weight of LiCl .. Li = 7'002 \pm 0'015
From ratio (3) „ = 7'0287 0'042
From ratio (4) „ = 7'0085 0'008

General mean „ = 7'0073 0'007

If O = 16, then Li = 7'0235. Stas himself gives 7'022 as his determination. Difference, 0'0015.

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Saturday, November 24, 1883.

Prof. CLIFTON, President, in the Chair.

PROF. REINOLD read a paper by Mr. J. W. CLARK, "On the Purification of Mercury by Distillation in vacuo." The advantages of Mr. Clark's apparatus are the small quantity of mercury in use at a time, and the fact that no auxiliary Sprengel pump is required. This is avoided by having a movable reservoir of mercury, on raising which the distiller is filled with mercury. The apparatus was described in detail, and illustrated by a figure. It is probable that zinc, cadmium, magnesium, &c., may be distilled, and thus purified by the same apparatus.

Mr. A. P. CHATTOCK then read a paper "On a Method of Determining Experimentally the Constant of an Electro-Dynamometer." In existing methods it is necessary to measure the areas of the coils, which is a difficult matter to do with a finished instrument: by the new method this is unnecessary. It depends on the accurate determination of the speed of the movable coil. Mr. Chattock exhibited an instrument whose constant had been determined by him in the laboratory of Prof. Foster, University College, with the assistance of Mr. Grant.

Professor G. C. FOSTER then took the chair, and

Professor R. B. CLIFTON (President) read a paper "On the Measurement of the Curvature of Lenses." With very small lenses the spherometer cannot be used, and the author's method is based on the Newton's rings formed between the lens and a plane surface or a curved surface of known radius. From the wave-length of the light employed in observing, and the diameter of a ring, the radius of curvature can be determined. He places the lens on a plane or curved surface under a microscope, and lights it by the sodium flame (wave-length 5892×10^{-7}). He measures the approximate diameters of two rings a distance apart (in practice the tenth and twentieth rings are found convenient), takes the difference of their squares, and divides it by the wave-length and the number of rings in the gap between to find the radius of the lens. The formula is—

$$\rho^1 m \lambda = (x_{m+n}^2 - x_n^2)$$

where x_{m+n} and x_n are the diameters of the n th and $(m+n)$ th rings, and λ is the wave-length of the light, and ρ^1 the radius of curvature of the lens. The method with proper care gives accurate results. Prof. Clifton has also used it to determine the refractive index of liquids in small quantities, Mr. Richardson having found it for water = 1'3335 by this method, which is usually correct to two places of decimals. It can also be used to determine if the lens is uniformly curved and spherical.

Professor PERRY suggested that it might be also used to measure a surface without touching it; say the surface of a water drop or a strip of glass when bent. In this way it might throw light on the laws of capillarity or of bending.

* Zeit. Anal. Chem., 1, 402.

† Annales de Chim et de Physique, 51, 103.

‡ Aronstein's Translation, 279–302.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvi., No. 19, November 5, 1883.

New Aperiodic Galvanometer.—G. Le Goarant de Tromelin.—The instrument in question has six poles formed by three horseshoe magnets with limbs very close together. These three fixed magnets are placed horizontally, one above the other, at a distance of 0.005 metre. The frame encloses the two poles of the middle magnet, leaving play-room sufficient to permit it to oscillate freely and to obtain 20 degrees of deviation on each side. The wire of this small and very light frame is perpendicular to the axis of the magnets, and the current arrives there by a suspension wire, as in Sir W. Thomson's syphon-recorder. If this galvanometer is connected with the two ends of a telephone from which the vibrating plate has been removed, the mere fall of a fragment of iron-filing, weighing a few milligrammes, upon the pole of the magnet of the telephone is sufficient to cause a deviation of the frame.

Electric Resistance of certain Insulating Substances.—G. Foussereau.—The author has studied the resistance of sulphur and phosphorus in different conditions.

Influence of Sodium Nitrate and Potassium Nitrate upon the Cultivation of Potatoes.—P. P. Dehérain.—In the author's experiments the nature of the base combined with the nitric acid did not modify the results. The sodium nitrate is converted into potassium nitrate at the expense of the salts of potassium present in the soil. Hence it is only in soils poor in potash that potash-salt-petre gives results superior to those obtained with soda-salt-petre. The potato does not, however, assimilate salts of soda.

Researches on the Physiological Properties of Maltose.—E. Bourquelot.—The author has examined the action of digestive ferments and of the acids of the human economy upon maltose.

External Use of Metallic Copper as a Preservative against Cholera.—Alex. Lamm.—The author suggests that the immunity from cholera enjoyed by certain places where copper-mining and smelting are carried on is due not so much to the metal as to the sulphurous acid, which he states is given off at Fahlun in intolerable quantities.

Comparative Poisonous Action of Metals upon the Microbia.—Ch. Richet.—To obtain the microbia the author used sea-water in which a small quantity of peptone had been dissolved. This liquid rapidly swarms with microbia. He found the metals fatal to microbia in the following order:—Mercury, zinc, cadmium, copper, nickel, iron (ferric salts), barium, lithium, magnesium, manganese, ammonium, calcium, sodium, and potassium. The poisonous dose for bacteria is in general about twenty times greater than for fishes. The author points out the extremely poisonous character of ammonium and potassium for fishes, whilst towards microbia they are comparatively inert.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome x., Sept., 1883.

Determination of Carbon Disulphide in the Sulpho-carbonates.—M. A. Müntz.—Already noticed.

Contribution to the Chemical Theory of Secondary Batteries.—Prof. E. Frankland.—From the *Proceedings of the Royal Society*.

Cosmos les Mondes.

No. 8, October 20, 1883.

This number is taken up with abstracts and selections from the travels of J. B. Tavernier in Tonkin.

No. 9, October 27, 1883.

This number contains no chemical matter.

MEETINGS FOR THE WEEK

MONDAY, Dec. 3rd.—Medical, 8.30.

— Royal Institution, 5. General Monthly Meeting. Society of Chemical Industry. "On a New Residual Product from Coal-gas," by H. L. Greville. "Further Notes on the Stassfurt Industry," by C. N. Hake. Drs. Raydt and Kunheim's Liquid Carbonic Acid Apparatus, exhibited by A. Zimmerman.

— Society of Arts, 8. "The Scientific Basis of Cookery," By W. Mattieu Williams, F.C.S.

TUESDAY, 4th.—Institute of Civil Engineers, 8.

— Pathological, 8.30

WEDNESDAY, 5th.—Society of Arts, 8. "The Manufacture of Mineral Waters," by Thomas T. P. Bruce Warren.

— Geological, 8.

— Pharmaceutical, 8.

THURSDAY, 6th.—Royal, 4.30.

— Royal Society Club, 6.30.

— London Institution, 7.

— Chemical, 8. Ballot for the Election of Fellows. "On the Constitution of the Fulminates," by Dr. Divers and M. Kawakita, M.E. "On Liebig's Production of Fulminating Silver without the Use of Nitric Acid," by Dr. Divers and M. Kawakita, M.E. "Note on the Constitution of the Fulminates," by Dr. H. E. Armstrong, F.R.S. "Experimental Investigation on the Value of Iron Sulphate as a Manure for certain Crops," by A. B. Griffiths.

— Parkes Museum, 8 p.m. Lecture by Dr. G. V. Poore, on "Coffee and Tea."

SATURDAY, 7th.—Physical, 3. "On the Static Telephone as an Instrument of Research; On a New Insulating Support; and On the First Law of Electrostatics," by Prof. S. P. Thompson. "Experiments Illustrating the Attraction and Repulsion of Bodies in Motion," by J. Monckmann, D.Sc. "An Integrating Anemometer," by Walter Bailly.

Wanted, by a Coal-Tar Colour Manufacturer, a Chemist for the Laboratory. One who has worked on cresol and its derivatives will find preference.—Address, "Beta," CHEMICAL NEWS Office, Boy Court, Ludgate Hill, London, E.C.

Wanted, Situation by Chemist (25) well up in manufacture of nitric, sulphuric, pure muriatic, fluoric acids &c.; sulphide, bisulphite, hyposulphite of soda, oxalates, baryta and strontia salts, pure alumina.—W. B., 4, Strauraer Place, Maida Vale, W.

Wanted.—"Researches on the Solar Spectrum and the Spectra of the Chemical Elements," by G. Kirchhoff. (First part.) Translated by Prof. Koscoe.—Address, H.E., CHEMICAL NEWS Office, Boy Court, Ludgate Hill, London, E.C.

Wanted, in a small Chemical Works near London, an Assistant for the Laboratory, having some chemical knowledge.—State previous occupation, age, and salary required, to S. A. P., CHEMICAL NEWS Office, Boy Court, Ludgate Hill, London, E.C.

Wanted, the Makers' Names of the following: Chloride of Magnesium, Chloride of Zinc, and Soluble Oil.—Address, "Chloride," CHEMICAL NEWS Office, Boy Court, Ludgate Hill, London, E.C.

An Old-established Manufacturing Chemical Business for Disposal.—The Plant and Machinery are constructed on the most improved principle, and are in good and substantial condition, for the distillation and manufacture of products from gas-tar and ammoniacal water, comprising, amongst other articles, naphthalene, anthracene, paraffin wax and spirits, creosote for preserving wood, lubricating oils and compounds, railway, tram, and machinery greases, varnishes, &c. There is also the necessary plant for the manufacture of lithographic inks. The premises are compact, and well situate for shipping, with private siding into the L. & N.W. Railway, with ample land for any extension of works. Capital required, about £12,000. As there is an efficient staff, a previous knowledge of the business not actually necessary.—For further particulars, principals or their solicitors, apply to Thos. Green, Esq., Wold House, Hawarden, near Chester.

THE CHEMICAL NEWS.

VOL. XLVIII. No. 1254.

ON A "RENNET" FERMENT CONTAINED IN THE SEEDS OF *WITHANIA COAGULANS*.*

By A. SHERIDAN LEA, M.A., Trinity College, Cambridge.

THE Report of the Royal Gardens at Kew for 1881 contains abstracts of correspondence, in which it was pointed out that, in order to introduce a cheese-making industry in India, some vegetable substitute must be found for the ordinary animal rennet, since cheese made with the latter is unsaleable among the natives. In response to the above "Surgeon-Major Aitchison brought to the notice of the authorities at Kew that the fruit of *Punceria† coagulans*, a shrub common in Afghanistan and Northern India, possesses the properties of coagulating milk;" and experiments showed that an aqueous extract of the seed-capsules of the above plant does somewhat rapidly coagulate milk.

I was recently requested to make some experiments on the seeds of *Withania* to determine whether they contain a definite ferment with the properties of ordinary rennet and the applicability of such a ferment to cheese-making purposes.

The material supplied to me consisted of an agglomerated dry mass of seed-capsules and fragments of the stalks of the plant. When crushed in a mortar the whole crumbled down into a coarse powder, in which the seeds were for the most part liberated from the capsules. I picked out the larger pieces of stalk, sifted out the finer particles, chiefly earth and fragments of the capsules, and then by a further sifting I separated the seeds from the other larger particles. The seeds appeared to be each enveloped in a coating of resinous material, presumably the dried juice of the capsules in which they had ripened.

Taking equal weights of the seeds, I extracted them for twenty-four hours with equal volumes of (i.) water, (ii.) 5 per cent sodic chloride, (iii.) 2 per cent hydrochloric acid, (iv.) 3 per cent sodic carbonate. Equal volumes of each of the above were added in an acid, alkaline, and neutral condition, to equal volumes of milk, and heated in a water-bath at 38° C. The milk was rapidly coagulated by the salt and sodic carbonate extracts, much less rapidly by the other two; of the four, the salt extract was far the most rapid in its action. All subsequent experiments have shown that a 5 per cent solution of sodic chloride is the most efficient in the extraction of the active principle from the seeds.

There is no doubt that the substance which possesses the coagulating power is a ferment closely resembling animal rennet.

I. A portion of the 5 per cent sodic chloride extract loses its activity if boiled for a minute or two.

II. The active principle is soluble in glycerin, and can be extracted from the seeds by this means; the extract possesses strong coagulating powers even in small amounts.

III. Alcohol precipitates the ferment body from its solutions; and the precipitate, after washing with alcohol, may be dissolved up again without having lost its coagulating powers.

IV. The active principle of the seeds will cause the coagulation of milk when present in very small quantities, the addition of more of the ferment simply increasing the rapidity of the change.

V. The coagulation is not due to the formation of acid by the ferment. If some of the active extract be made neutral or alkaline and added to neutral milk, a

normal clot is formed, and the reaction of the clot remains neutral or faintly alkaline.

VI. The clot formed by the action of the ferment is a true clot, resembling in appearance and properties that formed by animal rennet, and is not a mere precipitate.

Having thus determined the presence of a rennet ferment in the seeds, I endeavoured to prepare an active extract, which should be applicable for cheese-making purposes. All the extracts of the seeds are of a deep-brown colour, and it appeared therefore, in the first place, desirable to obtain less highly coloured, if not colourless, solutions, which should still be active. In this I have so far failed. The precipitate caused by alcohol carries down the chief part of the colouring matter also, so that on being subsequently re-dissolved the solution is nearly as highly coloured as before the precipitation. The colour can be removed by using animal charcoal, but the ferment is at the same time destroyed. If all excess of charcoal is avoided and the solution is filtered at once, the filtrate is largely decolourised, but contains only traces of the ferment. Animal rennet is similarly removed by filtration through charcoal. The colour can be removed by the addition of very finely-powdered kaolin in a dry state, but, as before, the ferment activity is thereby destroyed. The same holds good of animal rennet. The colouring-matter is scarcely soluble in either ether or alcohol, so that no advantage is gained by a preliminary treatment with these before extraction with the salt solution. I have also endeavoured to get rid of the colour by treating the seeds as rapidly as possible with successive quantities of water before making the final extract. By using a centrifugal machine I was able to wash the seeds six or seven times with large volumes of water without their being exposed for any considerable time to the action of the water. Each portion of water was highly coloured and the seeds were thus freed from adherent colouring-matter. But, apart from the fact that some, though not much, ferment is thus lost, no special advantage is obtained, since the seeds are themselves coloured, and even after prolonged treatment with water the final extract is always of a dark brown colour.

In order to obviate the disadvantages of this colouring matter, if disadvantage it is, I have found it best to prepare very concentrated active extracts of the purified seeds, so that it should only be necessary to add a very small quantity of the extract in order to coagulate the milk and obtain a colourless curd. This I have done by grinding the dry seeds very finely in a mill and extracting them for twenty-four hours with such a volume of 5 per cent sodic chloride solution that the mass is still fluid after the absorption of water by the fragments of the seeds as they swell up. From this mass the fluid part may be readily separated by using a centrifugal machine (such as is used in sugar refining), and it can then be easily filtered through filter-paper. Without the centrifugal machine the separation of the fluid from the residue of the seeds is tedious and imperfect; 40 grms. of the seeds treated as above with 150 cub. centims. of 5 per cent sodic chloride solution gave an extract of which 0.25 cub. centim. clotted 20 cub. centims. of milk in twenty-five minutes, and 0.1 cub. centim. clotted a similar portion of milk in one hour. When added in these proportions the curd formed is quite white. The presence of the colouring-matter is, however, perhaps on the whole unimportant, since even a larger quantity of the ferment extract is added in order to obtain a very rapid coagulation the colouring-matter is obtained chiefly in the whey, the curd being white.*

The question of preparing an extract which should be capable of being kept for a considerable time is perhaps of importance. Ordinary commercial rennet usually contains a large amount of sodic chloride and some alcohol. One specimen I analysed contained 19 per cent of common salt, and 4 per cent of alcohol. I have, therefore, added

* A paper read before the Royal Society, Nov. 22, 1883.

† The genus *Punceria* is now reduced by botanists to *Withania*.

* It is extremely probable that some stage in the growth of ripening of the seeds of *Withania* might be found at which the development of colouring-matter is slight, while at the same time the ferment is present in considerable quantity.

to the 5 per cent chloride extract mentioned above, enough salt to raise the percentage of this to 15 per cent, and also alcohol up to 4 per cent. The activity of the extract is not appreciably altered by this, and such a preparation corresponds very closely in activity with a commercial solution of animal rennet with which I compared it. The possibility of making extracts which may be expected to keep is thus indicated, but of course time alone will show whether the activity of the ferment is impaired to any important extent by such keeping.

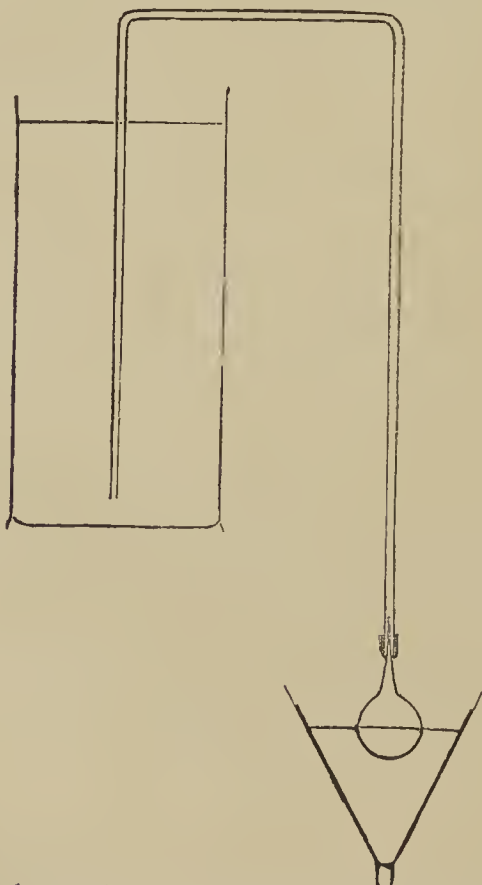
I may add in conclusion that I have coagulated a considerable volume of milk with an extract such as I have described, and prepared a cheese from the curds. I have also given a portion of the extract to a professional cheesemaker, who has used it as a substitute for animal rennet in the preparation of a cheese. The product thus obtained, and the statements of the person who has made the experiment for me, led me to suppose that extracts of the seeds of *Withania* can be used as an adequate and successful substitute for animal rennet.

AUTOMATIC FILTRATION.

By E. E. ROBINSON.

WHEN large quantities of liquids, such as reagents, have to be filtered in the laboratory, it is often convenient to have some means by which the filter is kept filled. The usual "bird-fountain" method which is applicable in some cases, has the disadvantage of requiring the inverting of large bottles or flasks filled with liquid, and besides this it does not maintain the liquid at a constant level in the filter.

The following apparatus has been found more convenient:—



To the longer limb of a syphon is attached a short piece of india-rubber tube projecting a little beyond the tube, the india-rubber is closed by the narrow conical stem of a small glass globe which floats on the surface of the liquid in the funnel; when the liquid rises to a certain height the float is lifted, and stops the flow of the liquid,

the narrow stem on the float which passes some distance into the syphon acting as a guide.

The apparatus keeps the liquid in the funnel at a constant level, and may be left without attention until the filtration is complete.

Chemical Laboratory, Cooper's Hill,
November, 1883.

ON THE SEPARATION OF COBALT AND NICKEL.

By JOHN CLARK, Ph.D., F.C.S., F.I.C.

IN 1879, M. Ph. Dirvell published a process for the separation of nickel and cobalt (CHEMICAL NEWS, vol. xl., p. 268), based upon the precipitation of the cobalt as ammonio cobaltic phosphate by means of microcosmic salt and bicarbonate of ammonia, prepared by saturating effloresced carbonate of ammonia with carbonic acid till all ammoniacal smell was gone. In carrying out the process, he added to an aqueous solution of the nitrates or sulphates of cobalt and nickel a quantity of a cold saturated solution of microcosmic salt equal to thirty times the weight of the two metals, and a volume of bicarbonate of ammonia equal to that of the microcosmic salt. The mixture was then slowly heated till the equivalent of carbonic acid in excess escaped, ammonia added to dissolve this precipitate, and the solution heated till the ammonio-cobaltic phosphate separated as a precipitate of a beautiful purple colour inclining to violet. This precipitate was found by analysis to have the composition— $(\text{NH}_4\text{O}, 2\text{CoOPO}_5 + 2\text{HO}) = \text{CoNH}_4\text{PO}_4 + \text{H}_2\text{O}$, and by ignition it is converted into the pyrophosphate of cobalt, $\text{Co}_2\text{P}_2\text{O}_7$. The nickel remains in solution, communicating to it a clear blue colour, and is only precipitated after protracted boiling. Dirvell states, further, that M. Pisani, in whose laboratory his experiments were made, had found that acetate of ammonia could be used instead of the bicarbonate of ammonia, and he gives certain directions for ascertaining approximately the proportions of cobalt and nickel from the colour of the solution.

So far as I am aware Dirvell has not published any of the results which he obtained by this method, and in endeavouring to carry out the process in the manner described, I found that when microcosmic salt and bicarbonate of ammonia were employed it was very difficult to precipitate the whole of the cobalt, and sometimes I failed to precipitate even a portion of it. With the acetate of ammonia and microcosmic salt the process worked better, but still in my experience unsatisfactorily. It appeared to me, nevertheless, that the process might be improved, and with that object I made a number of experiments, in the course of which I found:—

1. That phosphate of ammonia was the most suitable substance for precipitating the cobalt, but ordinary phosphate of soda can also be used.

2. In estimating the cobalt it is not necessary to use either bicarbonate of ammonia or acetate of ammonia, as chloride of ammonium, sulphate of ammonia, and nitrate of ammonia do as well as the acetate, and better than the bicarbonate.

3. In the case of phosphate of ammonia it is only necessary to use a little more than what is theoretically required to precipitate both cobalt and nickel as phosphate, but when phosphate of soda is employed a larger quantity seems to be necessary.

4. I have confirmed the correctness of the formula given by Dirvell to the ammonio-cobaltic phosphate.

Process.

In separating cobalt from nickel I proceed as follows:—The solution containing the two metals in the form of chlorides, nitrates, or sulphates is mixed with a moderate excess of phosphate of ammonia (about five times the

weight of the combined cobalt and nickel is sufficient), and for every part of phosphate of ammonia about 5 parts of ordinary hydrochloric acid are added, and the mixture is boiled for several minutes to make sure that all the phosphoric acid is in the state of ortho-phosphoric acid; the beaker or other vessel is then removed from the flame, and while still nearly boiling ammonia is added cautiously, in small quantities at a time, till the precipitate, which is at first produced, re-dissolves. The solution is then stirred vigorously for about a minute, when the cobalt will separate out as a fine purple crystalline powder, consisting of ammonio-phosphate of cobalt. About 10 drops of ammonia are then added, and the beaker placed for a few minutes on the top of a water-bath. When the precipitate has settled it is thrown upon a filter, washed with cold water, dried, ignited, and weighed as pyrophosphate of cobalt, $\text{Co}_2\text{P}_2\text{O}_7$, containing 40.4 per cent of cobalt. The filtrate from the cobalt will be more or less of a clear blue colour, the intensity depending on the quantity of nickel present. As the filtrate usually contains a small quantity of cobalt, it is advisable to heat it at 100°C . till a small quantity of the nickel begins to come down. If the whole of the cobalt has been thrown down, this precipitate will be green in colour, but if there was any cobalt in the solution it will be more or less red. In any case, it is filtered off, dissolved in hydrochloric acid, and any cobalt which it may contain is estimated as before, and the filtrate, which contains nickel, is added to the other nickel filtrate. The nickel may then be precipitated by saturating the ammoniacal solution with H_2S , filtering off the sulphide of nickel, igniting, then dissolving in nitro-hydrochloric acid, precipitating with caustic potash, and weighing as oxide.

The following experiments were made for the purpose of testing the accuracy of this process, and as there is nothing new in the method of determining the nickel, I have confined myself for the most part to the estimation of the cobalt:—

Expt.	Cobalt taken. Grains.	Nickel taken. Grains.	Weight of Pyrophosphate of Cobalt. Grains.	Cobalt found. Grains.	Nickel found. Grains.
I.	2.94	1.8	7.52	3.05	—
II.	2.94	1.8	7.28	2.94	—
III.	1.83	2.0	4.96	1.89	—
IV.	4.20	4.0	10.49	4.23	—
V.	3.67	0.5	9.09	3.67	0.53
VI.	4.20	0.2	10.38	4.19	0.23
VII.	0.18	2.0	0.45	0.18	—

An experiment in which sulphuric acid was used instead of hydrochloric acid gave the following result:—

Cobalt taken.	Nickel taken.	Wt. of Pyrophosphate of Cobalt.	Cobalt found.	Nickel found.
2.94 grs.	2.1 grs.	7.30 grs.	2.95 grs.	—

With nitric acid instead of hydrochloric acid the following result was obtained:—

Cobalt taken.	Nickel taken.	Wt. of Pyrophosphate of Cobalt.	Cobalt found.	Nickel found.
2.94 grs.	1.0 gr.	7.35 grs.	2.97 grs.	—

In addition to the above experiments, I have made a great many estimations of cobalt and nickel in cobalt ore by this process, and I am satisfied that it yields accurate and reliable results, not only with large quantities of cobalt in presence of small quantities of nickel, but also with small quantities of cobalt in presence of large quantities of nickel. I may mention that I have had occasion to submit this process to several chemists, to be used in the valuation of cobalt ores, and after trial they have admitted that they were satisfied with its accuracy. I may also add that it has been in constant use in a cobalt work for about a year, and that the chemist of the work, after comparative trials, has discarded the other processes in its favour.

In estimating cobalt and nickel in ores, I prefer to precipitate these metals as sulphides in an acetic acid solu-

tion. Great care requires to be taken to eliminate manganese, as that metal interferes with the correct estimation of the cobalt. The mixed sulphides, after ignition, are weighed for the purpose of ascertaining approximately the quantity of cobalt and nickel. They are then dissolved in nitro hydrochloric acid, and the cobalt estimated in the manner already described.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH KLARKE, S.B.
Chief Chemist to the U.S. Geological Survey, Washington.

RUBIDIUM.

THE atomic weight of rubidium has been determined by Bunsen, Piccard, and Godeffroy; but only from analysis of the chloride.

Bunsen,† employing ordinary gravimetric methods, estimated the ratio between AgCl and RbCl . His rubidium chloride was purified by fractional crystallisation of the chloroplatinate. He obtained the following results, to which, in a third column, I add the ratio between RbCl and 100 parts of AgCl :—

1 grm. RbCl gave	1.1873 grms. AgCl .	84.225
"	1.1873 "	84.225
"	1.1850 "	84.388
"	1.1880 "	84.175

Mean 84.253 ± 0.031

The work of Piccard‡ was similar to that of Bunsen. In weighing, the crucible containing the silver chloride was balanced by a precisely similar crucible in order to avoid the correction for displacement of air. The filter was burned separately from the AgCl , as usual; but the small amount of material adhering to the ash was reckoned as metallic silver. The rubidium chloride was purified by Bunsen's method. The results, expressed according to the foregoing standard, are as follows:—

1.1587 RbCl	=	1.372 AgCl	+ 0.0019 Ag .	84.300
1.4055 "	"	1.6632 "	0.0030 "	84.303
1.001 "	"	1.1850 "	0.0024 "	84.245
1.5141 "	"	1.7934 "	0.0013 "	84.313

Mean 84.290 ± 0.0105

Godeffroy,|| starting with material containing both rubidium and caesium, separated the two metals by fractional crystallisation of their alums, and obtained salts of each spectroscopically pure. The nitric acid employed was tested for chlorine and found to be free from that impurity, and the weights used were especially verified. In two of his analyses of RbCl the AgCl was handled by the ordinary process of filtration. In the other two it was washed by decantation, dried, and weighed in a glass dish. The usual ratio is appended in the third column:—

1.4055 grms. RbCl gave	1.6665 AgCl .	84.338
1.8096 "	2.1461 "	84.320
2.2473 "	2.665 "	84.326
2.273 "	2.6946 "	84.354

Mean 84.3345 ± 0.0051

Combining the three series, we get the following result:—

* Smithsonian Miscellaneous Collections. "The Constants of Nature."

† *Zeit. Anal. Chem.*, 1, 136. *Poggend. Annal.*, 13, 339. 1861.

‡ *Journ. f. Prakt. Chem.*, 86, 454. 1862. *Zeit. Anal. Chem.*, 1, 518.

|| *Ann. Chem. Pharm.*, 181, 185. 1876.

Bunsen	84.253	± 0.031	Rb = 85.150
Piccard	84.290	0.0105	,, = 85.203
Godeffroy	84.3345	0.0051	,, = 85.263

General mean 84.324 0.0045

Hence Rb = 85.251 ± 0.018 . If O = 16, Rb = 85.529.

The following additional note has been communicated by the author.—

Since the foregoing calculations were published, new determinations of the atomic weight of Rb have been made by Heycock (*Nature*, xxvi., 467). He titrated silver against the chloride of and bromide of rubidium, after Stas's method, and calculates the following values:—

From RbCl. Rb = 85.344.
From RbBr. ,, = 85.387.

The detailed weighings are not given. Probably, in calculation, Stas's values for Ag, Cl, and Br were used. —F. W. C.

CÆSIUM.

The atomic weight of cæsium, like that of rubidium, has been determined from the analysis of the chloride. The earliest determination by Bunsen,* was incorrect, because of impurity in the material employed.

In 1863 Johnson and Allen published their results.† Their material was extracted from the lepidolite of Hebron, Maine, and the cæsium was separated from the rubidium as bitartrate. From the pure cæsium bitartrate cæsium chloride was prepared, and in this the chlorine was estimated as silver chloride by the usual gravimetric method. Reducing their results to the convenient standard adopted in preceding chapters, we have, in a third column, the quantities of CsCl equivalent to 100 parts of AgCl:—

1.8371 grm. CsCl gave	1.5634 grms. AgCl	117.507
2.1295 " "	1.8111 " "	117.580
2.7018 " "	2.2992 " "	117.511
1.56165 " "	1.3302 " "	117.399

Mean 117.499 ± 0.025

Shortly after the results of Johnson and Allen appeared a new series of estimations was published by Bunsen.‡ His cæsium chloride was purified by repeated crystallisations of the chloroplatinate, and the ordinary gravimetric process was employed. The following results represent, respectively, material thrice, four times, and five times purified:—

1.3835 CsCl gave	1.1781 AgCl.	Ratio, 117.435
1.3682 " "	1.1644 " "	117.503
1.2478 " "	1.0523 " "	117.462

Mean 117.467 ± 0.013

Godeffroy's work|| was, in its details of manipulation, sufficiently described under rubidium. In three of the experiments upon cæsium the silver chloride was washed by decantation, and in one it was collected upon a filter. The results are subjoined:—

1.5825 CsCl gave	1.351 AgCl.	Ratio, 117.135
1.3487 " "	1.1501 " "	117.265
1.1880 " "	1.0141 " "	117.148
1.2309 " "	1.051 " "	117.107

Mean 117.164 ± 0.023

We may now combine the three series to form a general mean:—

* *Zeit. Anal. Chem.*, 1, 137.

† *Amer. Journ. Sci. and Arts*, (2.) 35, 94.

‡ *Pogg. ind. Anal.*, 119, 1. 1863.

|| *Ann. Chem. Pharm.*, 181, 185. 1876.

Johnson and Allen ..	117.499	± 0.025	Cs = 132.706
Bunsen	117.467	0.013	,, = 132.661
Godeffroy	117.164	0.023	,, = 132.227

General mean .. 117.413 3.010

Hence Cs = 132.583 ± 0.024 ; or, if O = 16, Cs = 132.918.

ELECTRO CHEMICAL RESEARCHES ON NITROGEN.

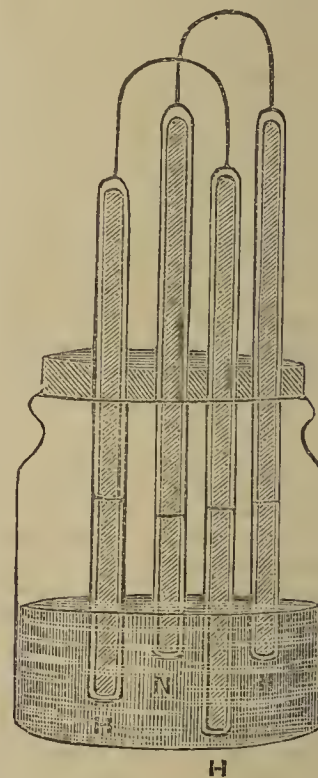
By GEORGE STILLINGFLEET JOHNSON.

(Concluded from p. 257.)

Experiments in which Hydrogen, Oxygen, and Nitrogen Gases in Grove's Gas Battery were simultaneously employed.

Two cells were filled with dilute sulphuric acid (sp. gr. 1.220), the tubes in each being respectively charged with hydrogen and oxygen gases. A third cell contained dilute hydrochloric acid (sp. gr. 1.100), and its tubes were charged with nitrogen and hydrogen gases. Connections were made between the hydrogen plate of the first cell and the oxygen one of the second, between the hydrogen plate of the second and the nitrogen plate of the third, and between the hydrogen plate of the third and the oxygen plate of the first, as shown in the accompanying diagram. (Fig. 3.)

FIG. 3.



In *Cell I.* the platinum plates were 10 inches in length. The oxygen gas in this cell surrounded 5.8 inches of the plate, the remaining 4.2 inches being immersed in the acid; whilst the hydrogen at first occupied 5.9 inches of the adjacent plate.

In *Cell II.* the plates 9 inches long, the oxygen surrounding 6.5, and the hydrogen 6.6 inches of their respective plates.

In *Cell III.* the plates measured 8.8 inches in length, of which the nitrogen covered 6.2 and the hydrogen 6.1 inches at the commencement of the experiment, the remainder of the plates being immersed in the hydrochloric acid. Contact was made between the plates with thick copper wire.

The first observation made was that the contraction of

the hydrogen and oxygen gases was much slower when the cells containing them were included in the same circuit with a cell containing nitrogen and hydrogen, and also the electric current passing from H to O was greatly enfeebled by the presence of the H and N in the same circuit.

For the first two hours, the nitrogen contracted alone very slightly. After forty-eight hours, the hydrogen in all three cells had contracted, so that the acid stood 1.5 inches higher in each hydrogen tube than at the commencement of the experiment. The oxygen in Cells I. and II. had undergone a contraction exactly half that of the hydrogens, whilst the gaseous contents of the nitrogen tube were increased, so that the acid stood at a level 0.7 inch lower in this tube than it had originally done.

A second experiment was made in which the same cells, the same platinum plates, and the same acids were employed, contact being made exactly as above described, and with the same copper wires.

In this experiment 5.2 inches of the oxygen plate of Cell I. was in gas, 4.8 inches of the adjacent plate being in hydrogen.

In Cell II. oxygen covered 5.9 inches of its plate, whilst 5.5 inches of the adjacent plate stood in hydrogen.

In Cell III. pure nitrogen occupied 3.1 inches of the left-hand plate, whilst the other plate was immersed in hydrogen to the length of 5.9 inches.

At first the nitrogen and hydrogen in Cell III. began contracting steadily in the proportion 1 to 3, the oxygen and hydrogen in Cells I. and II. maintaining a constant volume.

After one hour, however, contraction set in in Cells I. and II., the contraction of the hydrogen in Cell III. being at this time 1.5th of an inch, that of the nitrogen about a third of this amount.

During the next two hours the hydrogen in all three cells very slowly contracted, the oxygens in Cells I. and II. disappearing *half* as rapidly as their associated hydrogens, whilst the nitrogen in Cell III. retained a constant volume.

After twenty-one hours, the hydrogen in Cell III. had contracted 4.5ths of an inch, whilst the nitrogen in this cell had now a volume *equal* to its original one. The hydrogens in Cells I. and II. had each undergone a contraction of *half an inch*, whilst the oxygen in these cells had contracted a quarter of an inch.

After twenty-four hours more, the hydrogen in Cell III. had undergone a further contraction of *one inch*, whilst the nitrogen in this cell had expanded till the level of the liquid in its tube was 4.5ths of an inch lower than at first. A brisk evolution of small bubbles of gas was now seen pouring from the portion of the nitrogen plate immersed in the acid (evolution of hydrogen).

The hydrogen in Cell II. had contracted 9.10ths of an inch, whilst that in Cell I. had undergone a contraction of 4.5ths of an inch. The associated oxygens had each contracted half as much.

On making contact between the O plate of Cell I. and the H plate of Cell III. and a galvanometer, the first deflection of the needle amounted to 16° from H to O; permanent deflection 6° in the same direction. Cell I. and II. only being in circuit, a primary deflection of 48° was observed from H to O, followed by a permanent deflection of 7° in the same direction.

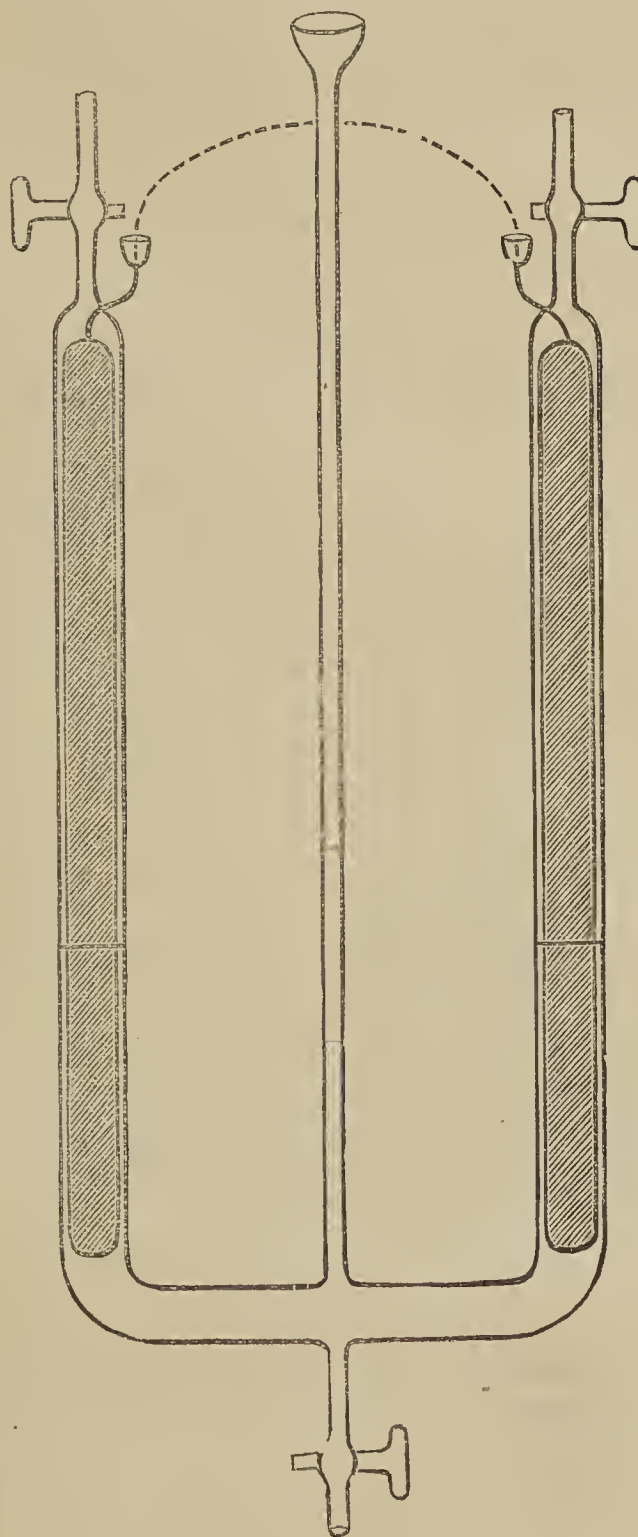
Experiments with Grove's Gas Battery in which Four Tubes were placed in One Cell.

I next endeavoured to induce a stronger polarisation of the nitrogen plate by connecting it with *three hydrogen plates* immersed in the same liquid, as shown in Fig. 4. The acid employed was hydrochloric of sp. gr. 1.100.

In my first experiments with this four-tubed cell, all the three hydrogen tubes being connected by means of thick copper wire with the nitrogen tube, I was surprised to find that, whilst two of the hydrogens contracted equally, the third underwent a much smaller contraction; and, on

repeating the experiment, this same tube showed a still more marked difference in the contraction undergone by its contents. I traced the cause of this to faulty contact between the copper wire and the platinum wire passing through this particular tube, for, on pushing the ivory cup at the top of this wire further on, so that the wire projected further into the cup and better contact was effected between it and the copper wire in several subsequent experiments, the contraction in *all three* hydrogen tubes was

FIG. 4.



exactly equal. This is an additional proof of the essentially electro-chemical character of the contraction observed.

The contraction of the hydrogens and the nitrogen gas in this apparatus usually continued equally in all four tubes for about three hours, after which the hydrogens all contracted together, whilst the nitrogen retained a constant volume, and subsequently began to expand. The

expansion of the nitrogen usually amounted to about one-third of the total contraction of the hydrogens.

When two cells, each containing four tubes, were connected together, the three hydrogens of the one with the one nitrogen of the other reciprocally, the gas in all the eight tubes contracted very slowly but equally to the amount of about 1-3rd of an inch. After thirty-six hours, no expansion had occurred in the nitrogen tubes, but twelve hours later the nitrogen in each cell had *expanded* $\frac{1}{2}$ inch, whilst the six hydrogens had each undergone a further *contraction* to an equal amount.

Evidence of the Formation of Ammonia by Combination of Nitrogen and Hydrogen in Grove's Gas Battery.

Special care having been taken to employ hydrochloric acid free from ammonia, and to avoid access of ammonia gas during the experiment, the following results are considered satisfactory.

20 c.c. of hydrogen gas having disappeared in the four-tubed cell above described, the acid in the cell, which was hydrochloric, of sp. gr. 1.100, was mixed with a solution of platinic chloride, and the resulting liquid evaporated down to a small bulk. 0.08 grm. of ammonio-platinic chloride was obtained, yielding the theoretical weight of platinum on ignition. Now, if 2-3rds of the hydrogen (20 c.c.) had combined with nitrogen, a quantity of am-

in the proportions 5 of air to 14 of hydrogen. This continued until about one fifth of the volume of the air had disappeared, after which the air began to expand, whilst the hydrogen still continued to contract.

When air and hydrogen were confined over H_2SO_4 (sp. gr. 1.220), the first deflection of the needle amounted to 6° from H to air. Permanent deflection 2° from H to air.

Oxygen and hydrogen in the same cell, over the same acid, gave a deflection at first of 25° , whilst the permanent deflection amounted to 4° .

Ammonia was found in the acid over which air and hydrogen had been contracting.

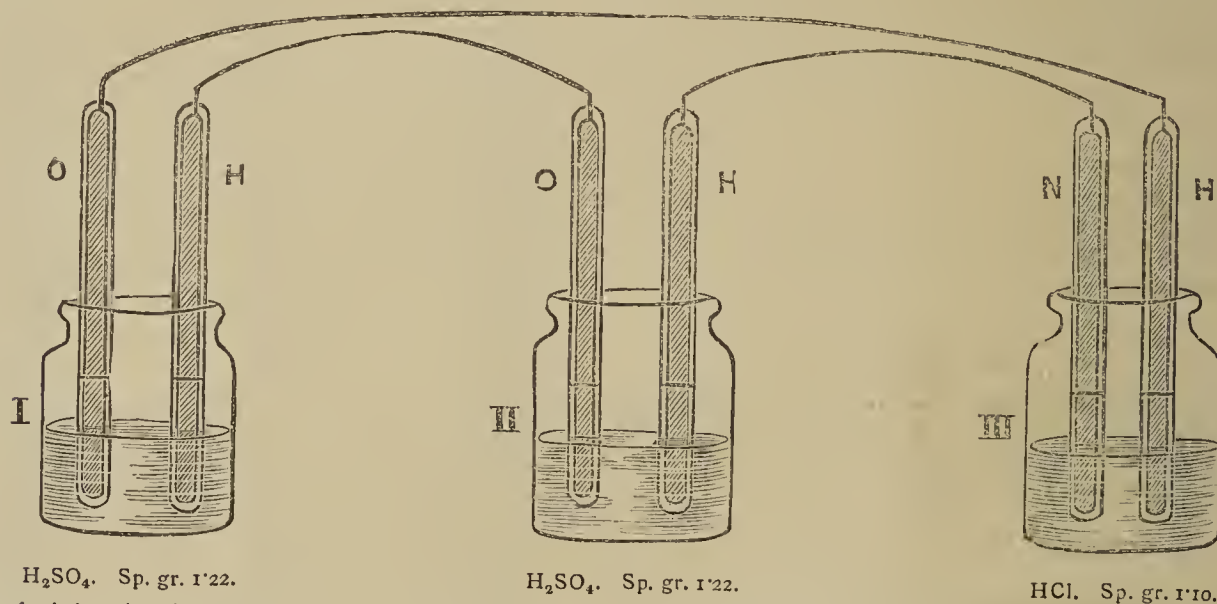
Experiments in which the Platinum Plates in Grove's Gas Battery were in similar Conditions, but in which the Results were Modified by the Action of the Effluve upon the Gases.

Besides the apparatus previously described, a specially devised cell was employed in the experiments, composed entirely of glass and platinum (see Fig. 5).

The experiments were conducted with pure H_2SO_4 in the cell, since it is essential, as before explained, that the nitrogen be perfectly *dry*, in order that it may be rendered active by the effluve.

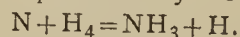
It was first ascertained by careful experiment that the

FIG. 5.



monio-platinic chloride would have resulted, weighing 0.084 grm. It seems, therefore, that a portion of the hydrogen eliminated from the N plate, combines with nitrogen to form ammonia, whilst the remainder accumulates as free hydrogen in the nitrogen gas.

As long as the nitrogen retains a constant volume, the change is probably represented by the equation—



But the accumulation of free hydrogen in the N tube gradually brings the two platinum plates into a similar electrical condition, hence the gradual diminution in the force of the electric current, and also in the amount of chemical combination occurring between the gases in the nitrogen tube.

Experiments with Air and Hydrogen in Grove's Gas Battery.

Having proved that nitrogen and hydrogen do combine, at all events partially, in Grove's gas battery, I determined to try a few experiments with air and hydrogen placed in the same conditions. My anticipation was that the oxygen would first combine, and that contraction would take place in the proportion 1 to 2, till all the oxygen of the air had disappeared. The result proved *different*. The contraction invariably took place at first

passage of the effluve round one of the tubes when both were filled with acid completely, did not produce the slightest disturbance of electrical equilibrium in the platinum plates, or at all events none that could be detected by the galvanometer which I made use of.

When pure *nitrogen* was introduced into both tubes, no current was observed. When one tube was left full of H_2SO_4 , and pure nitrogen was introduced into the other, a very feeble current at first set in towards the plate immersed in the acid from that surrounded by gas, deflecting the needle through 1° . By means of a piece of tin-foil wrapped round the exterior of the tube containing the nitrogen, the effluve was made to act upon the gas, one wire from the induction coil being connected with this tin-foil, and the other with the platinum plate in the interior through its wire. After passing the effluve for five hours consecutively through the nitrogen on four different occasions, and subsequently making contact with the galvanometer, currents were observed varying in intensity from 10° to 22° , but in all cases proceeding from the plate which was immersed in the acid towards that surrounded by the nitrogen gas. Thus the effect of the effluve upon the nitrogen was evidenced not only by an increased intensity in the current produced after electrification, but also by a complete change in the *direction* of the current.

When nitrogen and hydrogen gases were introduced into a cell containing 0.1 of vitriol, one of the platinum plates of which was somewhat more thickly platinised than the other, the nitrogen being in the more thickly platinised plate, and the two plates connected by a short thick copper wire; contraction took place in the proportion of 1 vol. of N to 3 vols. of H exactly, and continued for more than a week in the same proportions after the effluve had been passed through the nitrogen for about ten hours. Total contraction of nitrogen about 1 inch in a $\frac{1}{2}$ inch tube. At the end of the week the nitrogen began to expand, but again contracted on applying the effluve to it for six hours continuously and then connecting again with the hydrogenised plate. Thus by electrifying the nitrogen, that gas may be made to combine completely with the hydrogen generated from the portion of its plate immersed in the acid.

I was unable by means of the small coil in my possession to produce any current perceptible by my galvanometer by electrifying one of two nitrogen tubes in Grove's gas battery. Being, however, convinced that with electricity of higher tension, I should find it practicable to demonstrate this disturbance of equilibrium between two platinum plates, one surrounded by ordinary, the other by electrified nitrogen, I tried some experiments, with the kind help of Mr. W. Spottiswoode, with a very powerful induction coil fed by a dynamo-machine. I was enabled by means of the powerful current thus produced to observe very decided, though temporary, currents from the electrified nitrogen plate towards the other, but as I did not employ the same galvanometer, I cannot give comparative measurements of the intensity of the currents produced.

When nitrogen and hydrogen gases over H_2SO_4 were confined in the glass cell figured last, and the effluve from Mr. Spottiswoode's large coil was passed through the *nitrogen*, the following results were observed:—

1. Effluve passed through nitrogen for one hour and a half:—

Contraction of hydrogen = $3\frac{1}{2}$ inches.
" " nitrogen = $\frac{1}{2}$ inch.

2. Effluve through nitrogen for one hour and a half, the nitrogen having expanded again to its original volume during the week's interval which elapsed between the two experiments, whilst the hydrogen had not altered in volume:—

Contraction of H = 0.
" " N = $\frac{1}{8}$ th inch.

3. Effluve through N for one hour:—

Contraction of H = 0.
" " N = $\frac{1}{8}$ th inch.

4. Effluve through N for three-quarters of an hour:—

H first expanded $\frac{1}{2}$ inch, then contracted $\frac{3}{4}$ inch.
N contracted $\frac{1}{8}$ th inch.

Effect of the Condition of the Platinum Plates upon observed Phenomena in Grove's Gas Battery. Experiments in which the Two Plates were in Different Conditions as regards the State of their Surfaces.

The first fact established was that when the acid in the cell is as good a conductor of electricity as possible, and the two platinum plates are in directly opposite conditions as regards the smoothness of their surfaces, one being quite polished, whilst the other is thickly coated with electro-deposited platinum (platinised), no current could be perceived by my galvanometer so long as both tubes were full of acid only, and the plates were both devoid of occluded gases. Hence all the indication of electrical disturbance recorded must be attributed to the action of the *gases* employed upon the differently constituted plates and not to the action of the *acid* upon the plates.

When one tube contained a smooth platinum plate, the other a thickly platinised one, the acid in the cell being dilute sulphuric of sp. gr. 1.22, and both tubes being

partially charged with pure hydrogen gas, a deflection of 8° was observed on first connecting with the galvanometer, the current proceeding from the platinised plate to the smooth one. Slight contraction was also observed on the part of the gas in the tube containing the platinised plate. On allowing the acid to displace the hydrogen from both tubes, an initial deflection of 12° was observed by a current from the platinised plate to the smooth one. This current gradually diminished, and after twelve hours had completely ceased, no current passing between plates immersed in the acid and devoid of gas.

When a cell containing dilute sulphuric acid (sp. gr. 1.22), and having one plate smooth and the other platinised was charged with pure *nitrogen* in the *platinised* tube and pure hydrogen in the smooth one, a current passed from the *nitrogen plate* to the hydrogen one, deflecting the needle through 6° ; and, after standing for one month, the hydrogen was completely unchanged in volume, whilst the nitrogen had undergone only a very slight contraction. On displacing the gases from the two tubes by the acid, a current was observed proceeding from the platinised plate (nitrogen) towards the smooth one (hydrogen), which deflected the needle through 13° .

Same cell; same acid; same plates:—

Pure hydrogen introduced into the tube with the platinised plate and pure nitrogen into that containing the smooth plate. Initial deflection, 12° from H to N. After being connected for three days, the hydrogen had contracted only 2-5ths of an inch, whilst the nitrogen had contracted 1-10th of an inch. No further change of volume occurred after twenty-four hours additional connection. On displacing the gases by the acid, a current of 20° took place from the hydrogenised platinised plate to the smooth nitrogenised one.

These observations seem to me to prove that the action of nitrogen gas upon the platinum plate with which it is in contact, assists the action of hydrogen upon a plate connected with its own plate and immersed in the same acid. In short, the nitrogen appears to exist in the platinised plate in an electro-negative condition, and occasions a *positive* condition of the plate with which it is in contact, whilst the *electro-positive* hydrogen occasions a negative excitement of its adjacent platinum. The two plates being thus in opposite electrical conditions, a current is certain to take place from one to the other.

The occurrence of a current from a nitrogenised platinised plate towards a smooth hydrogenised one clearly proves that the direction of the current depends mainly upon the relative amount of electrical disturbance of the plates rather than upon the nature of the gas or of the positive or negative disturbance of either plate; and it certainly proves that nitrogen gas as it exists in contact with platinised platinum is not a purely inactive element.

In fact, however imperfect these researches may be, they seem to me to lend valuable additional evidence of the existence of an allotropic, active, and, I think I may now add, electro-negative form of *nitrogen*.

The description of the various experiments I have made with Grove's gas battery being somewhat detailed, it may be well to summarise briefly the results obtained and the inferences drawn therefrom:—

1. Nitrogen and hydrogen gases are capable of generating powerful currents in Grove's gas battery.
2. These currents are inversely proportional to the resistance offered by the acid in the cell.
3. The hydrogen always contracts in volume. If the resistance be great in the connecting wire between the two plates, whilst that in the acid is small, the nitrogen *expands* as much as the hydrogen contracts, no combination taking place between the gases.
4. When the resistance, both through the connecting wire and also through the acid, is reduced to a minimum, the nitrogen at first retains a constant volume, only expanding after a lapse of some hours,

and the total contraction of the hydrogen is often three times as great as the expansion of the nitrogen, a considerable proportion of the gases combining to form ammonia.

5. Complete combination of nitrogen and hydrogen gases to form ammonia, with contraction of both gases, in proportions N_1 to H_3 , may be effected by subjecting the nitrogen to the action of the effluve whilst it is in contact with a platinised platinum plate.
6. The contact of nitrogen with a platinum plate certainly produces a disturbance of the electrical equilibrium of the platinum, for a current may be demonstrated passing from a platinised platinum plate surrounded by nitrogen gas towards a smooth platinum plate immersed in pure hydrogen gas.
7. Nitrogen, in contact with a platinum plate, shows signs of electro-negativity in Grove's gas battery, which are intensified by the action of the effluve upon the gas, and hence the duality of nitrogen receives support from the phenomena described above.

King's College, London, 1883.

NOTICES OF BOOKS.

Energy in Nature, being, with some Additions, the Substance of a Course of Six Lectures upon the Forces of Nature and their Mutual Relations, delivered under the Auspices of the Gilchrist Educational Trust in the Autumn of 1881. By W. LANT CARPENTER, B.A., B.Sc., Fellow of the Chemical and Physical Societies, and of the Society of Chemical Industry. Cassell and Co., Limited: London, Paris, and New York.

THE work before us may be approximately considered as a popularised edition of the well-known *Correlation of Physical Forces*, with such additions and emendations, both in point of fact and theory, as the present state of knowledge demands. The author endeavours to explain at the outset the distinction between *force* and *energy*, still often confounded together, and to explain how and why "the language of the older books on the so-called Forces of Nature, the Correlation of Forces, &c., has been of late modified by the development of the doctrine of Energy and its Conservation." Says he: "The book may be shortly described as an endeavour to expound in popular, and yet accurate language, the meaning and consequences of that important principle known as the Conservation of Energy." This undertaking cannot be considered as other than highly laudable, since, without a clear underlying comprehension of this principle, scientific research and even scientific study will be, in most departments devoid of any sound and rational foundation. Mr. Carpenter may further be congratulated on the manner in which he has fulfilled his task. His book is the more opportune because a heresy has lately sprung up under the name of Substantialism, which, if we do not misunderstand its advocates, looks upon light, heat, and even sound, not as modes of motion, but as substantive entities. This doctrine is being zealously preached in America, chiefly by theologians, lawyers, military men, &c., who having the advantage of not understanding what they talk about can adduce arguments difficult to meet because beside the question.

In his successive chapters, or rather lectures, for such they originally were, the author discusses matter and motion, force and energy; heat as a form of energy, chemical attraction, especially combustion, electricity and chemical action; magnetism and electricity, and energy in organic nature.

The establishment of the doctrine of the Conservation of Energy is ascribed to "Meyer, Helmholtz, Clausius, and others in Germany, and to Grove, Joule, Thomson,

Balfour Stewart, Tait, Tyndall, and W. B. Carpenter, in England." The various shares of the work effected by these investigators and of the merit to which they are entitled are left to be ascertained by the reader from other sources.

On the cover of the book, and again on p. 13, we find a diagram intended to show the correlation of the forms of energy. As some of these forms the author places in a series of circles gravitation, mechanical energy, cohesion, magnetism, electrical attraction, moving electricity, radiant energy, heat, light, chemical attraction, vegetable energy, and animal energy. It is nowhere asserted—and the statement if made would be rash—that there may not exist in the universe other forms of energy with whose workings we are not acquainted. All these forms it is contended are capable, directly or indirectly, of mutual inter-conversion. It will also be understood that by vegetable and animal energy the author cannot mean life, since he says: "We do not exactly know what energy is, but we recognise it just as we recognise life in various forms." Here life is clearly distinguished from the forms of energy which nevertheless accompany it.

The subject of electricity and its relation to chemical attraction and to magnetism are discussed at a relatively great length and in an interesting manner. In the description of the telephone, however, its inventor, Reiss, is left out of sight.

The sixth chapter, which treats on energy in organic nature, contains some passages worth special notice. We read:—"It is a well-known fact that when people die of starvation the cause of death is really *cold*, i.e., inability to maintain the heat necessary for the vital processes; hence when food is scarce much less is needed if the body be kept warm; a fact noted by a careful Lancashire housewife, who during the last cotton famine kept the men of her household in bed and well covered up, for about twenty hours out of the twenty-four." It is not generally known that the phrase "to be starved," which in London and the South of England refers to the want of food, is in the North understood to mean suffering from cold.

It is a question whether in this book, as in many others, too much stress is not laid on the so-called "balance of organic nature." We do not know whether the vegetable creation exactly decomposes the supply of carbonic acid evolved by the respiration of animals and other sources, and consequently whether the relative proportions of that gas and of oxygen in the atmosphere are fixed or fluctuating. Still less do we know whether the totality of fixed or combined nitrogen in the earth, the waters, and the atmosphere is constant. That it undergoes constant waste by conversion into free nitrogen e.g. on the decomposition of animal and faecal matters, is established beyond doubt. But so far all attempts to detect an adequate recuperative process, whether of organic or inorganic nature, have given merely negative results. Hence it is with the greater surprise that we find Mr. Carpenter quoting in a note as "very suggestive in this connection," i.e., in reference to the balance of organic, an extract from a work entitled "Progress and Poverty," by Mr. Henry George. This author says: "That the earth could maintain a thousand billions of people as easily as a thousand millions is a necessary deduction from the manifest truth that, at least as far as our agency is concerned, matter is eternal and force must for ever continue to act."

To us it appears that the indestructibility of matter and the persistence of energy have no connection whatever with the population our earth is capable of supporting. Since a parcel of matter cannot be in two places at the same time the possible population of the earth is limited by the quantities of certain elements existing in certain states of combination which are manifestly not eternal. Let us suppose a small planet containing in its soils, waters, and atmosphere 1000 grms. of combined nitrogen. Suppose it inhabited by a race of beings each of which, on an average, required to contain in its body 1 gm. of combined nitrogen. It is therefore manifest that not more

than 1000 such beings could exist upon that planet at any given time. In reality the number would be much less, since a large share of the combined nitrogen would be locked up, temporarily in the plants used for food, and in the excreta of the inhabitants, and a portion wasted and as good as destroyed by reversion to the state of free nitrogen.

Our earth repeats the same state of the case on a larger scale.

It is to be regretted that such wild speculations should be reproduced in a work of such merit as the one before us.

Mr. Carpenter sums up the teachings of his book in the following set of propositions:—"That where one (of the forms of energy) is excited or exists, many others are also set in action; hence probably all are modes of motion; that any one may be transformed, either directly or by intermediate steps, into any other; that none of them can be produced but by some other as an anterior, and that they act uniformly, *i.e.*, according to fixed laws."

Annual Report of the Chemical Examiner's Department for 1882-83. (Bengal Medical and Municipal Department). Calcutta, 1883.

THAT "India is the only British colony in which there is no Pharmacy Act or law to regulate the sale of poisons," as this report tells us, may in some degree account for the very large number of cases of suspected poisoning that annually come under the chemical examiners' notice and which are recorded in this report. During the past year there were altogether 210 cases of human viscera examined (population not stated), poison being detected in 98 instances or 46.6 per cent of the number examined. Of the poisonous agents detected opium, arsenic, and aconite, take the first rank, and indeed almost make up the total number, with percentages of 26.6, 12.3, and 2.38 respectively. "These figures, though showing a slight improvement on the results of the previous year, and a greater improvement on the average of the five years ending 1879-80, are still far from being satisfactory."

The difficulties that the chemical examiner has to contend with as regards the way in which matters of such importance as the packing and rapid despatch to his laboratory of viscera, in cases of suspected poisoning, are certainly ludicrous, and seem to indicate a degree of laxity and carelessness on the part of the officers equal to that of the law-makers, who have as yet neglected the passing of a Pharmacy Act. We are told that "To many officers a daub of sealing-wax, or shell-lac, or a smudge with ink, in which no distinct impression is visible, does duty for a seal, and there can be no doubt that the object with which seals are directed to be affixed to parcels, &c., is not universally grasped." Advising the despatch of a stomach for analysis, the following is an example of the style of letter:—"I have despatched by a banghy parcel the stomach of Khaibe Byastabi for favour of your reporting result of the analysis. 'The opinion of the Hospital assistant of this sub-division is that death of the said woman is caused from the effects of some irritant poison.' No *post-mortem* report, no description of the mode of packing or copies of label attached to bottle." In another case liver, spleen, and intestines were sent, but no stomach, with the following report:—"I am of opinion that the man has died, seeing his internal organs congested!" Again—"My opinion that death may have resulted from poisoning, but I am not confident to say so: therefore, stomach needs be sent to the chemical examiner. As far as I think, it was an irritant, inorganic poison, perhaps foreign to me." This stomach was sent, but the contents had been thrown away by the native doctor! Evidently, in this latter case, the native doctor was partly in fault, but who, we should like to know, were responsible for the above very learned opinions. Were they English "trained" medical men in private practice, or those who have passed their examinations "with honours" into the

Government service? If native doctors, then they may reasonably be excused.

The subject of potable waters, a matter truly of the highest importance in such a climate as India, is considered at some length, and the great number of analyses that are embodied in the report are of value from a sanitary point of view. Appended to this report Dr. Warden gives the results of some interesting experiments he made on "Sui" poisoning, *i.e.*, poisoning by *Koonch* or *Goontch* seeds pounded and shaped into needles, which are employed by the natives for poisoning animals by forcing the needle through the skin of the victim. The original article on this subject is to be found in the *Indian Medical Gazette*.

Arithmetical Chemistry or Arithmetical Exercises for Chemical Students. By C. J. WOODWARD, B.Sc. Principal Chemistry and Physics Department, Birmingham and Midland Institute. Part II. London: Simpkin, Marshall, and Co., Birmingham: Cornish Brothers.

THIS work is a very favourable specimen of a class which has lately sprung up and which is likely to become more numerous. We fully admit that the student may derive much advantage from the treatment of a number of chemical questions from an arithmetical point of view. But at the same time we must earnestly deprecate the proposal which we have met with elsewhere to make such exercises stand in any way in the place of actual, intelligent, laboratory work. That a thorough mastery of what is taught in the little work before us will be of value to the student engaged in actual research is evident. But after a careful inspection of the exercises here given we fear that it will be of relatively greater utility to those who look upon chemistry, and indeed every other science, as something to be examined and to "pass" in. We find here a list of arithmetical chemical questions set at the University of London in the examinations for the degrees of B.Sc. and D.Sc. from the years 1873 to 1882; similar questions given at the Oxford Local Examinations, 1871 to 1882; arithmetical questions from Cambridge Local Examinations in chemistry, and similar questions propounded by the sphinx of modern England, the Science and Art Department, in its honours examinations from 1871 to 1883. It will be seen that not a few of these questions are what, in the language of the day, is called "pretty stiff." It will also be recognised that a thorough acquaintance with the teachings of Mr. Woodward's book will do very much towards a solution of these problems. But we cannot shut our eyes to the fact that a mere reader in chemistry—a pen, ink, and paper chemist, who had never performed a single experiment, nor even seen one performed—might be able to answer such questions as well as, possibly better than a skilful and successful investigator of chemical phenomena. It may be a weakness on our part, but we cannot help feeling jealous of anything which may tend to put these two classes upon an equality, or, still more, to favour the reader as against the worker.

Do we, therefore, condemn the book before us and similar publications? Certainly not; they have a legitimate sphere and in that they are useful. But such sphere is of a subordinate, auxiliary character. The danger is that unconscientious teachers, who care merely for what will "tell" at an examination, may be led to place an undue value upon such arithmetical problems and their solution.

A Manual of Chemistry. Vol I. Physical and Inorganic Chemistry. By H. WATTS, F.R.S. London: J. and A. Churchill.

THE work before us is avowedly based on the "Manual of Chemistry" of the late Professor Fownes, enlarged and modified in accordance with the present state of knowledge. It seems to hold a middle place between the ele-

mentary handbooks now so alarmingly common and the great systematic works, such as those of Miller, of Professor Roscoe and Schorlemmer, or the author's well-known "Dictionary of Chemistry." Its object is not to facilitate cram, or to fill the memory with undigested knowledge, but "to prepare the student for the perusal of original memoirs, which, in conjunction with practical instruction in the laboratory, can alone afford a real acquaintance with the spirit of research and the resources of Chemical Science." It is scarcely necessary for us to say that such a purpose has our earnest sympathy.

The work opens with a brief preliminary account of the more important elementary bodies, the laws of chemical combination and the representation of the constitution and the reactions of bodies by symbols and formulæ.

The next section is devoted to chemical physics, a subject now generally omitted in modern treatises on chemistry, in which the student is generally referred to special works on physics, not, perhaps, in all cases with advantage.

The author then proceeds to a review of the non-metallic elements. Immediately after hydrogen he takes up the halogens; then oxygen and its combinations with all the foregoing; sulphur and selenium, followed by tellurium. Arsenic also is classed as a non-metal, being made to succeed its near allies nitrogen and phosphorus.

After the non-metallic bodies have thus been systematically described the atomic theory is discussed with great fulness and clearness. Under "structural formulæ" we find the often repeated, but perhaps still more often forgotten, caution, that these formulæ "are not intended to represent the actual arrangement of the atoms in a compound; indeed, even if we had a distinct notion of the manner in which the atoms of any compound are arranged, it could not be adequately represented on a plane surface."

The part played by Mr. Newlands in the discovery of what is now known as the "periodic law" finds here due recognition. The nature of dissociation—sometimes misunderstood as a mere synonym for decomposition—is explained. So also are the foundations of thermo-chemistry.

The next portion of the work is devoted to the metals, the rarer and more recently discovered ones being here duly included.

Lastly follow tables of thermometric and hydrometric scales, and of the metrical system of weights and measures. The work may be characterised as containing a surprising quantity of correct information, clearly expressed and conveniently arranged. The index is very full, and, as far as we have been able to test it, accurate.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin.
Vol. 16, No. 5.

Condensation-Products of Acetacetic Ether.—A. Hantzsch.—Among the products obtained are mesityl-oxide dicarbonic ether, mesityl oxide anhydro-dicarbonic ether, and a crystalline body, the constitution of which is still doubtful.

Normal Primary Hexylic Alcohol and its Derivatives.—J. Frentzel.—The author has studied formic hexyl-ether, sodium hexyl-alcoholate, benzoic hexyl-ether, hexyl-chloride, and mono-hexyl-sulphurea.

Certain New Glyoxalines.—Br. Radziszewski.—An examination of glyoxal-iso-butyline, glyoxal-iso-amylene, and glyoxal-iso-cenanthylene.

Silver Hypophosphite.—Jul. Philipp.—Phosphorus, heated with dilute nitric acid in presence of silver nitrate,

is oxidised violently. Along with phosphoric and phosphorus acids there is formed a considerable quantity of phosphoric acid. On cooling, silver hypophosphite crystallises out, unless too much nitric acid is present.

Basic Glucinum Potassium Oxalate.—Jul. Philipp.—This salt is characteristic on account of its remarkable tendency to crystallise, and is therefore very serviceable for obtaining the glucinum compounds in a state of purity.

Glycocoll.—Theodor Curtius.—The author has studied the ethyl-ether of glycocoll and the substituted glycocolls.

The Connexion of the Combustion-heat of Isomeric Organic Compounds with their Density.—Müller Erzbach.—The differences in combustion-heat increase with the difference in density. This relation of organic compounds affords a new confirmation of the proposition deduced by the author from the volume relations of the most various classes of inorganic bodies that the transformations occasioned by chemical affinity press the active masses more and more together with a constant increase of the mean density, according to the principle of the least space.

Determination of the Influence of the Temperature and Concentration of Hydrochloric Acid upon the Rate of Inversion of Saccharose.—Fr. Urech.—Not susceptible of useful abstraction.

Formation of Nitrile Bases from Organic Acids and Amines.—Aug. Bernthsen.—The author argues that a base described, *Berichte*, xv., 3011, is formed by the direct action of benzoic acid and diphenylamine.

Nitroso-oxindol and Nitroso-indoxyl.—A. Baeyer.—Referring to a paper by Gabriel (*Berichte*, xvi., 518), the author states that he had made the same observations some time previously, and in concert with Comstock and Sapper and with Victor Meyer has begun an investigation on the constitution of nitroso-oxindol and nitroso-indoxyl.

Journal de Pharmacie et de Chimie.

Tome viii., November, 1883.

Observations on the Sanitary and Therapeutic Use of Copper Sulphate.—A. Riche.—The fact that bacteria and their germs cannot survive in contact with a certain dose of copper sulphate, does not prove that disease germs are unable to enter the organism of a person who has absorbed copper, and, having entered, to survive. The vitality of one and the same microbium varies extremely, according to the medium in which it lives. A microbium killed in a given solution by a certain dose of an antiseptic might resist the same dose if in the blood.

Certain Anhydrides and Mixed Anhydrides of Acetic Acid, and on Chlorinised Acetic Acids.—H. Anthoine.—The author describes dichloroacetic anhydride, trichloroacetic anhydride, a mixed acetic monochloroacetic anhydride, a mixed acetic dichloroacetic anhydride, and a mixed acetic trichloroacetic anhydride.

Preliminary Non-decomposition of Saccharose and Maltose in their Lactic Fermentation.—E. Bourquelot.—This paper does not admit of useful abridgment.

Waters of the South Oranais.—M. Baillon.—In Algeria there does not exist a definite relation between the flora and the fauna of waters and their sanitary value. Thus watercress, veronica, as well as the *Physali* and *Lymnæi*, which, according to certain authorities, are found in France only in good potable waters, have been found by M. Baillon in waters decidedly insalubrious.

Determination of Fatty Acids in Oils.—G. Krechel.—Inserted in full.

Memoir on Flours.—M. Balland.—Already noticed.

Detection of Carbon Disulphide.—M. Vitali.—The author fills a gasometer with pure hydrogen, which he allows to traverse a series of U-tubes, filled with frag-

ments of glass or of pumice steeped in lead nitrate, silver nitrate, and caustic potassa. For the same purpose may be used fragments of pumice steeped in sulphuric acid and in potassium permanganate. The liquid in which carbon disulphide is to be sought is introduced into a three-necked bottle connected to a second bottle containing tartar-emetic. A current of pure hydrogen is made to pass into the former, and then into the latter. The hydrogen is then conducted into a chloride of calcium tube, after which it may be treated with reagents, or the products of its combustion may be examined. In a first trial we receive the gas in a few c.c. of an alcoholic solution of caustic potassa, to which are afterwards added a very small quantity of neutral ammonium molybdate and a small excess of dilute sulphuric acid. If the liquid contains traces of carbon disulphide, it takes a rose colour, which then passes to a vinous red. Another portion of the gas is passed into a small volume of an alcoholic solution of lead acetate, to which are added a few drops of caustic potassa, and the mixture is heated to a boil. If the mixture contains carbon disulphide, lead sulphide is produced. If the quantity of carbon disulphide is large it becomes sensible to the smell. The flame has a blue centre, and gives off the odour of burnt sulphur. It decolorises blue starch-paper, blue starch-paper charged with iodic acid produces a yellow spot upon porcelain, which, if treated with caustic potassa and then with sodium nitroprusside or lead acetate, gives the reactions characteristic of the presence of sulphur. If a plate of silver is used instead of porcelain there appears a black spot of silver sulphide. If there are dropped upon the porcelain plate, solutions of caustic potassa, of lead acetate, cadmium sulphate, antimony chloride, or arsenious acid, and the flame is allowed to spread over these points of the plate, the characteristic colours of the metallic sulphides appear. If carbon disulphide is mixed in more or less considerable quantities with solid matters, they are divided as finely as possible, distilled along with water acidulated with sulphuric acid, and the distillate is further examined as above. If it is required to detect carbon disulphide in lighting-gas, the gasometer is filled with this gas, and the process is conducted as described.

MISCELLANEOUS.

The Liebig Memorial.—The *Chemiker Zeitung* reports that the statue of Liebig which was unveiled in August last has been wantonly, and it is feared permanently, injured. A black liquid, which appears to penetrate into the marble, has been thrown upon the head and left shoulder of the figure, and has run down to the pedestal.

Madrid Exhibition.—The well-known firm of Robert Daglish and Co., St. Helen's Foundry, Lancashire, have been awarded "Honourable Mention" for photographs of their Gold Reduction Machinery. This is certainly satisfactory for mere drawings; had the machinery itself been exhibited it would have had a gold medal awarded.

MEETINGS FOR THE WEEK

MONDAY, Dec. 10th.—Medical, 8.30.
London Institution, 5.
Society of Arts, 8. "The Scientific Basis of Cookery," By W. Mattieu Williams, F.C.S.
TUESDAY, 11th.—Institute of Civil Engineers, 8.
Photographic, 8.
Royal Medical and Chirurgical, 8.30.
WEDNESDAY, 12th.—Society of Arts, 8. "The Preparation and Use of Rheea Fibre," by J. Forbes Watson, M.A., M.D.
Microscopical, 8.
THURSDAY, 13th.—Royal, 4.30.
Philosophical Club, 6.30.
FRIDAY, 14th.—Astronomical, 8.
Quekett, 8.

TO CORRESPONDENTS.

G. T. D.—Most ammonium salts dissociate more or less when sublimed. Ammonium sulphate partially splits up in this way, but you cannot practically drive off the ammonia by heat from it.

THE PATENTS DESIGNS AND TRADE MARKS ACT 1883.

WITH INTRODUCTION, NOTES, AND INDEX
TO THE SECTIONS RELATING TO PATENTS.

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THE CHEMICAL NEWS.

VOL. XLVIII. No. 1255.

THE VOLUMETRIC DETERMINATION OF MANGANESE.

By GEORGE C. STONE.

In a paper* read before the American Institute of Mining Engineers at the Roanoke meeting, Mr. J. B. Mackintosh criticised some conclusions that I had stated in a paper† on the same subject read before the Institute at the previous meeting.

My original statement was:—

"Needing a rapid and tolerably accurate method for determining manganese in spiegel, I tried Williams's‡ method as promising better than any that I knew of. On making comparison analyses by it and the acetate and phosphate method, I found that it gave me only about ninety per cent of the manganese, the difference being always proportional to the amount of manganese. The method is based on the supposition that manganese is precipitated by potassium chlorate from a nitric acid solution entirely as MnO_2 . It occurred to me that this might not be correct; on trying it I found it was not. To test it I precipitated 0.5 gr. of a spiegel, in which I had previously determined the manganese by Ford's|| method, by potassic chlorate, and added the precipitate to a fresh solution of iron wire, made as is usual for standardising permanganate, and, after dissolving, determined the excess of unoxidised iron by permanganate which had just been standardised by the same iron wire dissolved in the same manner. The results were as follows:—

	I.	II.
Manganese found by Ford's method ..	0.0675	0.0679
Iron that would be oxidised if the precipitate were MnO_2	0.1374	0.1382
Iron actually oxidised	0.1117	0.1119

This result would give very nearly the formula $10MnO_2, MnO$. I then tried standardising the oxalic acid solution by a spiegel which had been repeatedly analysed by different chemists and obtained excellent results.

The method of analysis finally adopted is as follows:—Dissolve 0.5 gr. of spiegel in 40 c.c. nitric acid (1.42 sp. gr.) by boiling, add gradually an excess of potassic chlorate, cool, filter through asbestos (using a filter-pump), and wash three or four times with water. The precipitate will still contain some iron, but it does not interfere. Add the precipitate and asbestos to an excess of standard oxalic acid (8 to 8.5 grms. to one litre), add sulphuric acid, and heat till dissolved, titrate the excess of oxalic acid by permanganate (about 3 grms. to the litre)."

It will be seen from this that the method as I use it does not depend on the composition of the precipitate; but merely on its being of a definite and constant composition. It must be remembered that my conclusions as to the composition of the precipitate referred only to spiegel. Mr. Mackintosh reduced a measured volume of permanganate solution, precipitated with potassic chlorate, and determined the oxidising power of the precipitate by means of the same oxalic acid he had previously used for standardising his permanganate, and found the precipitate was MnO_2 . He entirely ignores the probable influence of the large amount of hydrocarbons present derived from the combined carbon of the spiegel and also the possible

influence of the large excess of iron. Further he neglected to directly determine the manganese present in his permanganate, but assumed that it was all present as $KMnO_4$, whereas, especially if the solution has been standing some time, it is apt to contain lower oxides.

To test the effect of different conditions I have tried reducing permanganate* by hydrochloric acid, evaporating to dryness, adding 0.5 grm. spiegel (the value of which in oxalic acid had been previously determined), dissolving the whole in nitric acid, precipitating by potassic chlorate filtering, and determining the oxidising power of the precipitate with the results shown in Table (see next page).

To further test the methods I have analysed a sample of spiegel by the methods in question (Williams's‡ method and the modification of it I proposed), and repeated the analysis, adding 0.2 grm. pure $Mn_2P_2O_7$ to each lot before dissolving, with these results:—

Spiegel used.	Manganese added.	Manganese found by Williams's method.	Gain.	Manganese found by modified method.	Gain.
Grm.	Grm.	Grm.	Grm.	Grm.	Grm.
0.5	—	0.10273	—	0.11037	—
0.5	—	0.10273	—	0.11037	—
0.5	0.07746	0.17434	0.07142	0.18749	0.07712
0.5	0.07746	0.17327	0.07054	0.18634	0.07597

The $Mn_2P_2O_7$ used I prepared from ferro-manganese with great care as follows:—I dissolved the ferro-manganese in nitric and sulphuric acids and evaporated till copious fumes of SO_3 were given off, diluted, and precipitated the iron as basic acetate as usual. I did not wash at all, but used only the filtrate, evaporated to dryness, took up with water and a few drops of acetic acid, boiled, and filtered from the small precipitate of iron that separated. I tested this filtrate for iron with ferrocyanide, but obtained no reaction. I then precipitated the manganese by bromine, filtered, and washed very thoroughly, dissolved in hydrochloric acid and precipitated as phosphate; filtered, washed, dissolved in hydrochloric acid, re-precipitated by ammonia and a little sodic phosphate; filtered, washed with the pump, dried, brushed from the paper, and ignited to pyrophosphate.

In reference to the manner of precipitating by potassic chlorate Mr. Mackintosh says:—"The manganese was precipitated by potassic chlorate; and, after standing some time to cool—a precaution which we consider of importance—the precipitate was filtered." (The italics are mine.) He, however, gives no reasons for considering it of importance to cool before filtering. As I usually filter hot, I thought it better to try whether it did make any difference; so tried it as follows:—

Sample No.	Filtered hot, found.	Filtered cold.
67	20.67 per cent	20.85 per cent.
313	11.81 „ „	11.69 „ „

In one case the solution filtered hot gave the higher result, in the other the one filtered cold; in neither case was the difference greater than would be allowable in duplicate analyses. He also says:—"Shortly after first employing the method we (Mackintosh, Beele, and Colby) noticed that the reaction was seldom complete when potassic chlorate was added during one period only. On this account it is necessary, in employing this method, to add alternate amounts of potassic chlorate and nitric acid, until no further effect is produced; and if this precaution is neglected, the results will almost invariably be low." As this is evidently meant to explain why I got low results when I first tried the method I would say that I have always added the potassic chlorate in successive portions until no further reaction was produced. I think the following analyses will show whether the different methods of

* CHEMICAL NEWS, vol. XLVIII., 1246, p. 176.

† Trans. Am. Inst. Min. Eng., vol. XI.

‡ Ibid., vol. X., p. 100.

|| Ibid., vol. IX., p. 397.

* I determined the Mn in the permanganate used and found it to agree very closely with the amount calculated from the oxidising power.

† Trans. Am. Inst. Min. Eng., vol. X., p. 100.

Spiegel used.	KMnO ₄ added.	Oxidising power in terms of KMnO ₄ .	Deduct for oxidising power of spiegel.	Oxidising power of precipitate from KMnO ₄ .	Theoretical for MnO ₂ .	Per cent of theoretical.	Theoretical for 10MnO ₂ .MnO.	Per cent of theoretical.
Grm.	C.c.	C.c.	C.c.	C.c.	C.c.	C.c.	C.c.	C.c.
0.5	—	24.49	—	—	—	—	—	—
0.5	—	24.49	—	—	—	—	—	—
0.5	45	40.60	24.49	16.11	18	89.50	16.36	98.47
0.5	35	36.98	24.49	12.49	14	89.21	12.72	98.19
0.5	25	33.58	24.49	9.09	10	90.90	9.09	100.00
Average per cent						89.87		98.89

working produce any appreciable effect; they were made on the same samples with oxalic acid standardised in the same manner:—

Sample 4.		Sample 76.	
Beele ..	13.85 per ct.	Mackintosh {	12.20 per ct.
" ..	13.98 "	" {	12.44 "
Stone ..	13.81 "	" {	12.92 "
" ..	13.88 "	" {	13.03 "
		Sands	12.31 "
		"	12.45 "

The two first analyses of 76 were Mr. Mackintosh's original determinations, the next two were "repeated with great care." Mr. Sands was formerly my assistant. He made the analyses in my laboratory when we were first investigating the method.

I think the experiments here given are sufficient to explain the difference in the results obtained by Mr. Mackintosh and myself, and to confirm my original conclusions.

N. J. Zinc and Iron Company,
Newark, N. J., Nov., 1883.

THE PURIFICATION OF AMMONIUM FLUORIDE.

By PETER T. AUSTEN and FRANCIS A. WILBER.

ONE of the most convenient methods of determining silica in titaniferous and other ores is to expel it as fluoride by means of ammonium fluoride and sulphuric acid, or by fluorhydric acid alone. But the practical difficulty here met is the impossibility of getting either ammonium fluoride or fluorhydric acid in a pure state, for it is of course absolutely necessary that they should leave no residue after volatilisation. The following procedure has enabled us to use the articles obtainable in commerce with excellent results.

The amount of ammonium fluoride necessary for the analysis is dissolved in as little water as possible in a platinum dish, and strong ammonia added in slight excess. If fluorhydric acid is used the ammonia is added in small amounts from a pipette, so as to avoid spitting. In this case the operation is of course performed under a good hood. In both cases a voluminous precipitate will be obtained. A five-inch filter-paper, which has previously been extracted* with fluorhydric acid to remove silica, is folded to the sixteenth fold, making a cone of an angle of about 67°. If the papers are very thin it is well to take two of them and fold them together. This cone is then placed in a ring of stout platinum wire, which may be conveniently held in the ring of a ring-stand by three smaller platinum wires. The liquid is decanted into this filter and allowed to filter at once into the platinum crucible containing the ore. The crucible is then placed on a water-bath and the liquid concentrated. This step is not necessary unless the bulk of the liquid is large or the crucible small, and indeed had better be avoided, since

* Papers freed from ash by treatment with chlorhydric and fluorhydric acids are now manufactured by Schleicher and Schull by a method described by me in 1878 (CHEMICAL NEWS, 37, 149) and tested and approved by Profs. Fresenius and Caspari (Zeitschrift für analytische Chemie, 22, 241).—P. T. A.

ammonium fluoride is quite volatile. The liquid is next made acid with sulphuric acid, evaporated to dryness and ignited as usual. Should it be feared that the silica had not been entirely expelled, the operation should be repeated; but it will be found that as a rule one treatment is sufficient. The ammonium fluoride prepared in this way we find does not leave any appreciable residue. Of course every new lot or ammonium fluoride or fluorhydric acid, before being used in analysis, should be tested for residue after treatment in this manner.

We prefer to use the acid in analysis, purifying it and converting it into the ammonium salt by the above method, for its cost is but one-third of that of the ammonium fluoride and it affords a more concentrated solution,—*Amer. Chem. Journ.*

THE VOLUMETRIC DETERMINATION OF COMBINED NITROUS ACID.

[By LEONARD P. KINNICUTT and JOHN U. NEF.

THE amount of nitrous acid contained in commercial samples of potassic and sodic nitrites has been commonly determined in the following manner. The nitrites are dissolved in slightly acidulated water; a solution of potassic permanganate is added till the oxidation of the nitrous acid is nearly completed; the solution is then made strongly acid, and potassic permanganate added until the solution has a faint red colour.

This method is far from satisfactory, closely agreeing results being rather the exception than the rule. The cause is most probably due to the escape of a small amount of nitrous acid, and also to the slow oxidation of the last traces of the nitrous acid by the potassic permanganate.

A further study of the analyses of nitrites volumetrically seemed desirable, and after numerous experiments the following process, or modification of the old process, as it might more properly be called, was devised.

The sample of nitrite is dissolved in cold water, one part of the salt to at least three hundred parts of water. To this solution a decinormal solution of potassic permanganate is added, drop by drop, till the liquid has a decided and permanent red colour, then two or three drops of dilute sulphuric acid, and immediately afterwards an excess of the potassic permanganate solution. The liquid, which should now be of a dark red colour, is made strongly acid with sulphuric acid, heated to boiling, and the excess of potassic permanganate determined by means of a decinormal solution of oxalic acid.

Analyses of samples of both potassic and sodic nitrites, made in accordance with the above modification, show that results agreeing very closely with one another can easily be obtained.

Potassic Nitrite Solution.

(One litre contained 4.3550 grms.).

Taken.	KNO ₂ found.
25 c.c. = 0.1089 gm.	0.09194 gm. = 84.44 per cent.
35 c.c. = 0.1525 "	0.1289 " = 84.48 "
40 c.c. = 0.1742 "	0.1472 " = 84.51 "
55 c.c. = 0.2395 "	0.2024 " = 84.49 "
60 c.c. = 0.2613 "	0.2210 " = 84.53 "

Sodic Nitrite Solution.

(One litre contained 3.090 grms.).

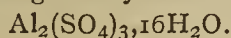
Taken.	NaNO ₂ found.
25 c.c. = 0.0919 gm.	0.07713 gm. = 83.95 per cent.
35 c.c. = 0.1287 "	0.1082 " = 84.07 "
45 c.c. = 0.1654 "	0.1390 " = 84.05 "
53 c.c. = 0.1949 "	0.1639 " = 84.03 "
60 c.c. = 0.2206 "	0.1854 " = 84.05 "

The volumetric method for the determination of sulphites is also most unsatisfactory. The study of this subject was therefore given to Mr. R. Penrose, a student in this laboratory. He experimented both with potassic permanganate and oxalic acid as above, and also with iron alum and the permanganate; but although many variations of these processes were tried, and the work carefully conducted, the results were not satisfactory.—*Amer. Chem. Journ.*

ALUMINIUM SULPHATE.

By SPENCER U. PICKERING, M.A. (Oxon.)

In the *Comptes Rendus*, xcvi., 844, I see that P. Marguerite-Delacharlonny states that pure aluminium sulphate crystallises with 16 molecules of water, and not with 18, as is usually asserted. On referring to some notes of 1881, I find that I obtained results confirmatory of this statement, aluminium sulphate, on re-crystallisation and drying between blotting-paper, having been found to yield analytical numbers agreeing closely with the formula—



A RECALCULATION

OF

THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

THALLIUM.

THE atomic weight of this interesting metal has been fixed by the researches of Lamy, Werther, Hebbeling, and Crookes. Lamy and Hebbeling investigated the chloride and sulphate; Werther studied the iodide; Crookes's experiments involved the synthesis of the nitrate. The last mentioned work was so thorough and admirable that the other researches are included here only for the sake of historical completeness.

Lamy† gives the results of one analysis of thallium sulphate and three of thallium chloride. 3.423 grms. Ti_2SO_4 gave 1.578 gm. BaSO_4 ; whence 100 parts of the latter are equivalent to 216.920 of the former. In the thallium chloride the chlorine was estimated as silver chloride. The following results were obtained. In the third column I give the amount of TiCl proportional to 100 parts of AgCl :—

3.912 grms. TiCl gave 2.346 AgCl .	166.752
3.000 " " 1.8015 "	166.528
3.912 " " 2.336 "	167.466

Mean 166.915 \pm 0.1905

Hebbeling's‡ work resembles that of Lamy. Reducing his weighings to the standards adopted above, we have from his sulphate series, as equivalent to 100 parts of

BaSO_4 , the amounts of Ti_2SO_4 given in the third column :—

1.4195 gm. Ti_2SO_4 gave 0.6534 gm. BaSO_4 .	217.248
1.1924 " " 0.5507 "	216.524
0.8560 " " 0.3957 "	216.325

Mean 216.699

Including Lamy's single result, as of equal weight, we get a mean of 216.754 \pm 0.1387.

From the chloride series we have these results, with the ratio stated as usual :—

0.2984 gm. TiCl gave 0.1791 AgCl .	166.611
0.5452 " " 0.3278 "	166.321

Mean 166.465 \pm 0.097

Lamy's mean was 165.915 \pm 0.1905. Both means combined give a general mean of 166.555 \pm 0.0865.

Werther's* determinations of iodine in thallium iodide were made by two methods. In the first series TiI was decomposed by zinc and potassium hydroxide, and in the filtrate the iodine was estimated as AgI . 100 parts of AgI correspond to the amounts of TiI given in the last column :—

0.720 gm. TiI gave 0.51 gm. AgI .	141.176
2.072 " " 1.472 "	140.761
0.960 " " 0.679 "	141.384
0.385 " " 0.273 "	141.026
1.068 " " 0.759 "	140.711

Mean 141.012 \pm 0.085

In the second series the thallium iodide was decomposed by ammonia in presence of silver nitrate, and the resulting AgI was weighed. Expressed according to the foregoing standard the results are as follows :—

1.375 gm. TiI gave 0.978 gm. AgI .	Ratio 140.593
1.540 " " 1.095 "	140.639
1.380 " " 0.981 "	140.673

Mean 140.635 \pm 0.016

General mean of both series, 140.648 \pm 0.016.

From the foregoing results three values for the atomic weight of thallium are calculable :—

From the sulphate	$\text{Ti} = 204.169 \pm 0.166$
From the chloride	" = 203.879 0.126
From the iodide	" = 203.886 0.054

In 1873 Crookes,† the discoverer of thallium, published his final determination of its atomic weight. His method was to effect the synthesis of thallium nitrate from weighed quantities from absolutely pure thallium. No precaution necessary to ensure purity of materials was neglected; the balances were constructed especially for the research; the weights were accurately tested and all their errors ascertained; weighings were made partly in air and partly in vacuo, but all were reduced to absolute standards; and unusually large quantities of thallium were employed in each experiment. In short, no effort was spared to attain as nearly as possible absolute precision of results. The details of the investigation are too voluminous, however, to be cited here; the reader who wishes to become familiar with them must consult the original memoir. Suffice it to say that the research is a model which other chemists will do well to copy.

The results of ten experiments by Professor Crookes may be stated as follows. In a final column we may state the quantity of nitrate producible from 100 parts of thallium. The weights given are in grains :—

* Smithsonian Miscellaneous Collections. "The Constants of Nature."

† *Zeit. Anal. Chem.*, 2, 211. 1863.

‡ *Ann. Chem. Pharm.*, 134, 11. 1865.

* *Journ. f. Prakt. Chem.*, 92, 128. 1864.

† *Phil. Trans.*, 1873, p. 277.

Thallium.	TiNO ₃ +Glass.	Glass Vessel.	Ratio.
497.972995	1121.851852	472.557319	130.3875
293.193507	1111.387014	729.082713	130.3930
288.562777	971.214142	594.949719	130.3926
324.963740	1142.569408	718.849078	130.3900
183.790232	1005.779897	766.133831	130.3912
190.842532	997.334615	748.491271	130.3920
195.544324	1022.176679	767.203451	130.3915
201.816345	1013.480135	750.332401	130.3897
295.683523	1153.947672	768.403621	130.3908
299.203036	1159.870052	769.734201	130.3917

Mean 130.3910 \pm 0.00034

Hence, using the atomic weights and probable errors previously found for N and O, $Tl = 203.715 \pm 0.0365$. If $O = 16$, $Tl = 204.183$.

Crookes himself, using 61.889 as the molecular weight of the group NO_3 , gets the value $Tl = 203.642$; the lowest value in the series being 203.628, and the highest 203.666; an extreme variation of 0.038. This is extraordinary accuracy for so high an atomic weight, at least as far as Crookes's work is concerned. But its value depends in reality upon the accuracy of other chemists in fixing the atomic weights of N and O; a slight variation in either of the latter constants producing a large variation here. What Crookes really has done has been to fix with almost absolute certainty the ratio between Tl and NO_3 . If the latter group should have the molecular weight 62, in accordance with Prout's hypothesis, then $Tl = 204.008$. In other words, the ratio thus fixed by Crookes is almost exactly represented by two whole numbers, and supports Prout's hypothesis in a very decided way. Crookes himself seems to have overlooked this fact, for he regards his results as militating against the hypothesis in question.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, December 6, 1883.

Dr. W. H. PERKIN, F.R.S., President, in the Chair.

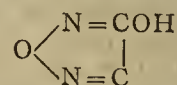
DURING the evening the following gentlemen were declared by the Scrutators of the ballot, Messrs. A. J. Greenaway and A. K. Miller, duly elected Fellows of the Society:—F. A. Blair, T. J. Barr, C. J. Baker, L. Briant, R. G. Durrant, Kamchandra Datta, L. L. Garbutt, A. E. Harris, T. Hart, W. Irwin, S. Johnson, R. Jackson, H. C. Lee, W. H. Martin, C. E. Potter, B. M. H. Rogers, C. W. Stephens, P. H. Wright, H. A. Wetzel, W. G. Whittam.

The following certificates were read for the first time:—B. H. Brough, G. Daubeney, C. C. Hutchinson, W. S. Kilpatrick, E. Matthey, J. W. Pallister, H. Peile, S. G. Rawson, W. Robinson, F. M. Rogers, R. Romanis, W. O. Senior, T. Stenhouse, J. A. Voelcker.

The following papers were read by the SECRETARY:—*"On the Constitution of the Fulminates,"* by E. DIVERS and M. KAWAKITA. The attention of the authors has been drawn to the chemistry of the fulminates, through the recommendation of mercury fulminate, by Steiner, as a source of pure hydroxy-ammonium chloride, a fact previously discovered by Carstanjen and Ehrenberg. The authors find that pure hydroxy-ammonium chloride, free from ammonia, is obtained by the action of strong hydrochloric acid on moist mercury fulminate, as stated by the above chemists; they find, however, that much hydrocyanic acid is also formed, although not a trace is produced if the fulminate be dry, a theoretical yield of hydroxy-ammonium chloride being obtained. This substance is strongly acid to litmus-paper. The authors ascertained that the whole of the carbon in mercury ful-

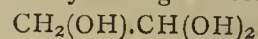
minate, when treated with concentrated hydrochloric acid, is converted into formic acid. The authors have utilised this reaction to make an analysis of mercury fulminate, the mercury being precipitated by hydrogen sulphide. They obtained the following numbers:—Mercury, 70.40 per cent; nitrogen, 9.85 per cent; carbon, 8.17 per cent. Not a trace of oxalic acid is produced in the above decomposition.

"Theory of the Constitution of Fulminates," by E. DIVERS. After discussing the various formulæ suggested by Berzelius, Kekulé, Armstrong, and Steiner, and a lengthy consideration of the formation, decompositions, and properties of the fulminates, the author gives the following as the probable constitution of fulminic acid:—



"On Liebig's Production of Fulminating Silver without the Use of Nitric Acid," by E. DIVERS and M. KAWAKITA. According to Liebig, fulminating silver separates in large needles and without ebullition when nitrous acid is passed into an alcoholic solution of nitrate of silver. The authors have repeated this reaction and obtained crystals, but they consisted of silver nitrate with a trace of some organic silver salt, which is not fulminate. A second experiment, in which silver nitrate and silver nitrite were added to alcohol and nitric acid (sp. gr. 1.35), then dropped in with shaking, also gave no fulminate. The authors conclude that even nascent nitrous acid, alcohol, and a silver salt do not yield a fulminate, but that an energetic oxidation of the alcohol by a mixture of nitric acid and either mercury or silver nitrate alone, seems to be effective. The paper concludes with an account of some unsuccessful attempts to form fulminating copper.

Dr. ARMSTRONG then read a short *"Note on the Constitution of the Fulminates,"* by H. E. ARMSTRONG. In this note the author supports his previous views as to the constitution of fulminic acid, or rather a slight modification of them $(\text{HO.N})\text{C.C.H}(\text{NO})$, against the criticism of Dr. Divers in the previous paper, and briefly considers the probable nature of the reaction between alcohol, nitric acid, and mercury. It is not probable that the fulminate is the immediate product of the action of nitrous acid (this note was written before the last paper of Divers and Kawakita was received) upon alcohol, and it is almost certain that alcohol, when treated with dilute acid, has its atoms of hydrogen displaced one by one by hydroxyl. Thus, a body having the constitution—



is formed, and this body the author regards as the primary source of the fulminate which is formed by the simultaneous, or perhaps consecutive, action of nitrous acid and hydroxylamine.

Dr. GLADSTONE said it ought to be remembered that the formula of a substance depended to a great extent upon the reactions by which it is produced, and that it was often very difficult to find a formula which expressed all reactions. He should have liked the formula to have expressed more clearly the formation of sulphocyanide and urea by the action of ammonia and hydrogen sulphide.

Dr. ARMSTRONG said it was not possible to express all reactions in all cases, because the products were often not immediate, but formed by secondary decompositions.

The PRESIDENT thought some light might be thrown on the subject by investigating the secondary products of the oxidation of alcohol as to the formation of formic acid. It was very gratifying to receive communications from Japan, where the facilities for research must be small. Possibly such communications might serve as a stimulus to chemists at home to give a little more time to research.

The SECRETARY then read a paper entitled *"Experimental Investigations on the Value of Iron Sulphate as a Manure for certain Crops,"* by A. B. GRIFFITHS. In a previous paper (*Chem. Soc. Journ.*, 1883, Abstracts, 496) the author gave the results of some experiments as to

the effect of iron sulphate on the growth of single plants. In the present paper he gives the results obtained on the large scale with plots of land near Bromsgrove, Worcestershire, with crops of beans and wheat. One plot was treated with commercial crystallised ferrous sulphate, 56 lbs. to the acre; the other was left in its normal state. The total weight of the dry crop (grain and straw) from the plot manured with ferrous sulphate was 5882 lbs.; from the normal plot 44'87 lbs. The former yielded 56 bushels of beans, the latter 35 bushels. The ash of the entire plant and of the pods in the plot manured with iron manure contained much more iron and phosphoric acid than those from the normal plot. The beans from the two plots exhibited but little difference in these respects. In the case of the wheat crops, although the iron manure produced much heavier and finer plants, the ashes did not show much difference as to iron and phosphoric acid. The author has also grown some plants in pots, exposing each pot to a different portion of the spectrum. The soil in which they grew contained ferrous sulphate. Those plants growing in the yellow yielded an ash containing 2'5 per cent Fe_2O_3 ; those in the violet 0'15 per cent Fe_2O_3 .

Mr. WARINGTON said the paper contained many valuable facts, although some of the statements seemed to require modification or further investigation. There seemed to be no doubt that an increase of 21 bushels of beans was obtained by the addition of the ferrous sulphate. The author seemed to have overlooked the fact as to the increase of phosphoric acid, that one crop had many more pods than the other, and so the increase of phosphoric acid was only an increase in the relative number of pods. He was very sceptical as to the occurrence of crystals of ferrous sulphate, mentioned in this and the previous paper, in proximity to the chlorophyll granules.

The Society then adjourned to December 20, when a paper, "Researches on the Constitution of the Gums of the Arabin Class," by C. O'Sullivan, will be read.

PHYSICAL SOCIETY.

Saturday, December 8, 1883.

Prof. G. CAREY FOSTER in the Chair.

NEW Members:—Major McGregor, R.E.; Mr. James Walker, M.A.; Mr. W. B. Gregory, B.A.

Prof. SILVANUS P. THOMPSON, D.Sc., &c., read a paper "On the Static Induction Telephone as an Instrument of Research." The author had employed Dolbear's telephone in investigating the action of influence machines, such as those of Holtz and Wimshurst, or Toepler. This was done by holding the end of a wire (connected to one terminal of the telephone) near the electrified parts of the machine: for example, the "carriers" in the Toepler apparatus. The carriers induced a charge in the telephone (whose other terminal was to earth) as they passed, and the pitch of the note heard in the telephone increased with the speed at which the machine was driven. Useful results were obtained, leading to modifications of some machines. The same telephone was also applied to the measurement of capacities of condensers arranged like the resistances of a Wheatstone Balance, and the telephone taking the place of a galvanometer. For the "divided coil" of the balance, Prof. Thompson substituted a double condenser, or rather two condensers, so joined that the earth plates were separate, while the other plates were in one. This device was made from two glass tubes with tinfoil round their outsides, and a brass tube sliding into both interiors in such a way that the relative capacities of the two condensers thus combined could be altered by sliding the tube between them. A modification of this plan was suggested by Mr. Starling, the author's assistant, which was analogous to Prof. Foster's arrangement of the Wheatstone balance; that is to say, six con-

densers were used, the two extra ones being included between the battery connections and the sliding tube. The battery was in this case an induction coil having no condenser, as a discontinuous current is necessary to give sounds. The author also showed that the Dolbear telephone could be used instead of the quadrant electrometer in such experiments as those of Mr. J. E. H. Gordon on specific inductive capacity. The author also showed how he had applied it to explore the equipotential surfaces round conductors charged statically by an induction current. With two wires from the terminals of a telephone silence is produced when both ends are on the same equipotential surface, and sounds when they are not.

Prof. THOMPSON then read a "Note on a New Insulating Stem." This consisted of a glass tube with one end blown into a flat foot, which was planted on the bottom of a glass bottle, and cemented there by a little wax paraffin. The upper and open end of the tube served to hold the stems of brass plates, or other electrified bodies. Paraffin oil or strong sulphuric acid could be used in the bottom of the bottle. A cap of rubber or percha made to slide up the stem served as a dust cover.

Prof. THOMPSON next made a communication "On the First Law of Electrostatics," and illustrated his remarks with experiments showing how a series of floating magnet poles of like name, repelling one another, tend to produce equal distribution of the poles. Prof. Thompson, arguing from the second law of electrostatics (inverse squares), sought to explain the first law in a rational manner, on the hypothesis of self-repelling molecules, which tend to uniform distribution. When there is a surplus in one part and a deficit in another, the molecules are urged towards each other, *i.e.*, attract. This was shown by putting a surplus of floating magnets at one part of the basin. By the movements of these magnets, when confined in barriers and with surplus and deficit purposely made, the author imitated the effects of a Leyden jar, induction, a battery current, &c., the motions and arrangement of the poles illustrating the hypothetical behaviour of electricity. The author was led by the hypothesis to infer that either the ether is electricity, or that the ether is electrified, and the former seemed the simpler conclusion.

Dr. MONKMAN showed some "Experiments Illustrating the Attraction and Repulsion of Bodies in Motion." The attraction of a light balanced body to a vibrating tuning-fork was shown; also the attraction between two disks of paper revolving parallel and in the same direction. The author showed that two smoke-rings travelling abreast in the same direction attracted each other, and that two paper rings revolving in the same direction close together attract, while if revolving in the other direction they repel.

Mr. WALTER BAILY exhibited his new "Integrating Anemometer" in action by means of a small electric motor, which took the place of the Robinson cups. The apparatus sums up or integrates the wind velocities on the lines of the four cardinal points. An electric counter is attached.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, Monday, Dec. 3, 1883.

GEORGE BUSK, Esq., F.R.S., Treasurer and Vice-President, in the Chair.

HENRY BROWN, B.A., Oxon, James Duncan, F.C.S., William Thomas Sugg, C.E., Mrs. Mary Willis Tanner, Thomas Tyrer, F.C.S., were elected members of the Royal Institution.

Seven Candidates for Membership were proposed for election.

The decease of Sir William Siemens, Manager and Vice-President, on November 19th, was announced from the Chair.

The following resolution, passed by the Managers at their meeting this day, was read:—

"In the death of Sir William Siemens the Royal Institution has lost an eminent member and a generous friend. The outcome of his great practical researches was frequently brought before us in lectures delivered in our theatre; he was our benefactor in presenting to us apparatus of great value; while his wise counsel, as a manager, was ever ready when the interests of the Institution required it. He showed his veneration for one of its Professors by naming a vessel—a model one of its kind—constructed under his personal supervision for the transport and laying down of telegraphic cables, 'The Faraday.' In everything he touched, practical genius, guided by a knowledge of principles not frequent among practical men, was displayed. In the domains of heat, electricity, and metallurgy he won his chief renown; and here the ultimate issues of his labours are at present incalculable. England, the land of his adoption, has lost through his death an engineer of singular power, penetration, and many-sidedness. The source of the quality last mentioned, by which he was characterised, was, first of all, inherent ability, and, secondly, the comprehensive scientific education which he received in the seminaries and universities of his native land. He came to us thoroughly equipped with the theoretic knowledge necessary for practical ends, and he applied that knowledge successfully in the most varied spheres of action. As regards invention he came of a family to the manner born: all his brothers, and especially his eldest brother, the celebrated Dr. Werner Siemens, having achieved distinction in applying science to the uses of life. William Siemens was a man of the most charming disposition, genial, kindly, without jealousy or bitterness, and as a natural result he secured not only the respect but the warm affection of those who intimately knew him. The members who were present on the occasion of our last monthly meeting will not readily forget the animated description he then gave us from the chair of a new application of steam power which he had just seen tried on the River Spree, near Berlin. How little could the freshness and the vigour of that exposition prepare his hearers for the catastrophe so soon to follow! Among the members of the Royal Institution he has left many mourning friends, who profoundly sympathise with his family in their great bereavement, and more especially with Lady Siemens in her irreparable loss."

The following lecture arrangements were announced:—

Professor Dewar, M.A., F.R.S., M.R.I.—Six Experimental Lectures (adapted to a Juvenile Auditory) on Alchemy (in relation to modern Science); on Dec. 27 (Thursday), Dec. 29, 1883; Jan. 1, 3, 5, 8, 1884.

Reginald Stuart Poole, Keeper of Coins, British Museum.—Two Lectures on the Interest and usefulness of the Study of Coins and Medals; on Tuesdays, Jan. 15, and 22.

Ernst Pauer, Principal Professor of the Piano-forte at the Royal College of Music.—Six Lectures on the History and Development of the Music for the Piano-forte and its Predecessors, the Clavichord, Harpsichord, &c. (with Musical Illustrations on these Instruments); on Thursdays, Jan. 17 to Feb. 21.

Professor Tyndall, D.C.L., F.R.S., M.R.I.—Six Lectures on The Older Electricity: its Phenomena and Investigators; on Thursdays, Feb. 28 to April 3.

Archibald Geikie, F.R.S.—Five Lectures on Tuesdays, Jan. 29 to Feb. 26.

Professor John G. McKendrick, M.D., F.R.S.E., Prof. Inst. of Med. Univ. of Glasgow, Fullerian Prof. of Physiology, R.I.—Five Lectures on Animal Heat: its Origin, Distribution, and Regulation; on Tuesdays, March 4 to April 1.

Professor Henry Morley.—Six Lectures on Life and Literature under Charles I.; on Saturdays, Jan. 19 to Feb. 23.

Captain W. De W. Abney, R.E., F.R.S., M.R.I.—Six Lectures on Photographic Action, considered as the Work of Radiation; on Saturdays, March 1 to April 5.

The presents received since the last meeting were laid on the table, and the thanks of the Members returned for the same.

NOTICES OF BOOKS.

Letts and Co.'s Diaries for the Year 1884.

THE firm of Letts, Son, and Co., Limited, still hold a decided pre-eminence in the production of diaries adapted to the most varied tastes, requirements, and circumstances of the public. The specimens before us range in size from the sturdy folio, fit for the desk of the merchant or manufacturer, to the neat gilt-edged volume for the pocket. The space devoted for each day varies from an entire page down to one-seventh of a page.

Among those editions which more particularly call for notice ranks the "Medical Diary," an elegant pocket volume. It contains an almanac adapted for entering the meetings of societies, tables for comparing thermometric degrees, instructions for restoring the apparently drowned, scales of professional fees; a list of poisons and their antidotes, in which, by the way, the soluble compounds of chromium are omitted; new drugs and remedies; a classified list of medicines; tables of normal weight of the human body; spirometry; therapeutic equivalents, hypodermic injections; temperature of baths; saturation-tables, chemical reactions of morbid urines, list of formulæ, &c., as well as useful information of a more general character, such as postal regulations. If we may venture a suggestion, it strikes us that a useful additional feature in this, and in every other diary intended for professional or other scientific men, would be a list of the regular meetings of the learned societies, which might be introduced into the almanac.

An examination of this diary brings under our notice an unsatisfactory point in the scale of fees for medical men when called upon to appear as experts in a court of law. We do not here claim in any way to speak on behalf of the medical profession, which has its own recognised organs. But we feel that the scale thus laid down may be held in certain points binding upon analytical chemists. It appears that the fee for making a post-mortem examination, which, according to the coroners' summons as quoted may include an analysis of the contents of the stomach, is one guinea! We are certain that in many cases ten guineas would be a barely sufficient remuneration for several days of exceedingly delicate work, requiring for its performance great skill and wide experience, and the consumption of a considerable quantity of absolutely pure, and therefore costly, reagents.

A curious form of diary is the "Monthly." In this kind, each month forms, for convenience of carriage, what may be called a separate pamphlet, the whole of which are ordinarily contained either in a book-like box, or in a morocco wallet.

The "Appointment Diary" is intended to provide "an hourly arrangement for the punctual keeping of engagements, especially those of professional persons, lecturers, and students." After an almanac, of somewhat mediæval character, and other usual information, follow certain blank pages for memoranda, &c. In the main part of the diary we see the days of the month, seven to the page on the left hand side, and on the right the corresponding days of the week placed as headings, whilst in the margin stand the hours of the day from 9 a.m. to 8 p.m. The engagements of the coming day, or week, are thus shown at a glance. This seems a very convenient arrangement. The book is of pocket size; it is issued in three different styles of getting up, and might, if needed, be brought into still smaller compass by omitting certain matter which, however generally useful, does not seem here particularly apposite.

The "Metallic Diary" is an elegant little book giving

a week on two opposite pages. At the end of some months, but not of others, follow a few blank pages, we presume for memoranda.

In this edition there is no printed matter beyond the almanac at the beginning.

The Housekeeper gives as its specialities a table of articles of food in season; tables for checking bills, times of high water; an alimentary table, in which we regret to find blood classed as an article of food; a register of rates and taxes, formidable in number; servants' engagement register; household gas register, wine register; addresses or memoranda; register of articles lent, &c. The bulk of the book is devoted to a classified account of daily expenditure. In this, and apparently in all the editions of the octavo and quarto series, Messrs. Letts still insert the least satisfactory feature of their diaries, their "concise directory," the exceptionable character of which we have pointed out on a former occasion.

The "Commercial Tablet Diary" shows an entire week at a glance, and is so arranged that it may be suspended by a loop, the weeks that are passed being turned over backwards.

As favourable specimens of the commercial or office diary may be taken the 8vo. No. 8 and the folio 51. When it is remembered that those editions which we have specially mentioned are merely specimens out of a great number, each bearing some distinctive feature, the enterprise of Messrs. Letts in meeting the wants of the public will be duly appreciated.

CORRESPONDENCE.

THE DIRECT UNION OF NITROGEN AND HYDROGEN.

To the Editor of the Chemical News.

SIR,—In a paper published in the CHEMICAL NEWS (vol. xlviii., p. 187) I brought forward a criticism on the statement of Mr. Stillingfleet Johnson, that nitrogen and hydrogen united directly under the influence of heated spongy platinum. I showed that hydrogen passed through a solution of silver nitrate, yields ammonia when passed over heated spongy platinum, by reacting with the nitric oxide produced by the decomposition of silver nitrate. Mr. Johnson, in the succeeding number of the CHEMICAL NEWS, stated that he had obtained ammonia when silver nitrate was not used to purify the hydrogen. He was kind enough to send me a copy of his paper read before the Royal Society in 1881, in which these experiments were described. The nitrogen was prepared by passing air over sawdust coated with freshly precipitated ferrous sulphide, and allowing the gas so obtained to stand over water containing ferrous ferrocyanide in suspension. It was purified by passing (1) through a U tube containing fragments of caustic potash; (2) through strong sulphuric acid; (3) through alkaline pyrogallate of potash. The hydrogen was prepared from zinc and dilute sulphuric acid, and purified by chromic and sulphuric acids. The mixed gases were passed through a set of bulbs containing Nessler's solution, over heated spongy platinum, and through a second set of bulbs containing Nessler's solution. Mr. Johnson found that it was possible to get 1.5 milligrams of ammonia from 10 litres of nitrogen. I repeated these experiments and found that ammonia was produced from the gases prepared and purified in the way that Mr. Johnson described. I found, however, that the length of time during which the nitrogen was exposed to the action of the ferrous ferrocyanide had an influence on the amount of ammonia produced. The gas which had stood over the ferrocyanide for three days gave about twice as much ammonia as the gas which had only stood for six hours. To see what effect was produced by the omission of the shaking up with ferrocyanide in the process, I filled a gas-

holder with the gas prepared by drawing air, bubble by bubble, through a long tube containing sawdust and ferrous sulphide. The removal of oxygen was completed by passing the gas through alkaline pyrogallate. With this gas slight traces of ammonia were produced, when it was mixed with hydrogen and passed over heated spongy platinum. This experiment shows that when the nitrogen is allowed to stand over ferrous ferrocyanide, some substance is given up to it, which will produce ammonia when passed over heated spongy platinum. The gas prepared from air by shaking up with ferrous ferrocyanide in suspension in water, gave ammonia when it was passed over heated platinum without any admixture of hydrogen.

I have prepared nitrogen in four different ways without the use of heat, to see if any "active" nitrogen could be obtained from the air by methods which involved the use of no agent containing combined nitrogen. The oxygen of the air was absorbed (1) by cold moist phosphorus; (2) by an alkaline solution of pyrogallate of potash; (3) by water holding ferrous hydrate in suspension; (4) by a solution of sodium zinc hyposulphite, prepared by dissolving zinc in a solution of sodium hydrogen sulphite. The nitrogen from these sources gave no ammonia when mixed with hydrogen and passed over heated spongy platinum.—I am, &c.,

H. BRERETON BAKER.

Balliol College, Oxford.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvi., No. 21, November 19, 1883.

Volcanic Phenomena of the Straits of Sunda.—M. Daubrée.—The ashes thrown out contain soluble chlorides in considerable quantity. If heated in a closed tube they give a white deposit, giving off a little water with a very acid reaction and a slight bituminous odour. The white matter on oxidation gives off a sulphurous odour. Mineralogically the ash consists of octahedral crystals of ferrous oxide, small black fragments of pyroxene augite, a great number of transparent fragments of hypersthene, colourless crystals of felspar, and crystals of pyrites.

Purple Dye of the Ancients, according to a Fragment attributed to Democritus.—M. Berthelot.—The author states that the works of Democritus or of his disciples formed a kind of philosophical and scientific encyclopædia, which was collected and arranged in Tetralogies by Thrasyllus, in the reign of Tiberius, but which has unfortunately been lost, with the exception of some fragments collected and published by Franck in 1836, and by Mullach in 1843. M. Berthelot, whilst examining the Greek alchemical manuscripts in the National Library, found the fragment in question given in the original Greek, and in the following version:—

"Putting in a pound of purple, . . . place it on the fire until ebullition; then, removing the decoction from the fire, put the whole into a vessel, and, withdrawing the purple, pour the decoction upon the purple, and let steep for a night and a day. Then, taking 4 lbs. of orchil, pour water upon the weed to the depths of four fingers, and let it become thick. Filter, heat, and pour upon the wool. Let steep for two nights and two days. Take out and dry in the shade; and to 2 lbs. of the liquor add water so as to make up the original quantity. Repeat until it becomes thick; then, having filtered, re-enter the wool as before, and let it steep for a night and a day. Lift and rinse in urine, and dry in the shade. Take *laccha* (probably alkanet), put it with 4 lbs. of sorrel, and boil with

urine till the sorrel is reduced. Having clarified the water, put in the alkanet, boil until thick, filter again, enter the wool, then wash afresh with urine, and afterwards with water. Dry in the shade, and expose to the vapour of sea-weeds steeped in urine. . . . The following wares enter into the composition of the purple:—The weed which is called false purple, the coccus (a kind of cochineal), the sea colour (orchil), the crismos (?), alkanet, Italian madder, the phyllanthion of the divers, the "purple worm" (probably another sort of cochineal), the rose of Italy. These colours are esteemed by our predecessors. There are colours to be avoided and which are of no value: The cochineal of Galatia, the colour of Achaia, which is called laccha, that of Syria, called rhizion (an inferior madder?), the shell-fish of Libya, and of the coast of Egypt, called pinna, the woad of the upper region, and the colour of Syria called murex. These colours are not fast, and, except woad, are not esteemed among us."

[The obscurity of this passage is in great part due to our ignorance of the technical terminology of the Greek language.]

Production of very Low Temperatures by Means of Continuous Apparatus.—M. Cailletet.—The author has sought to utilise the intense cold produced by the release of compressed gases. He has arranged a cylinder of steel, perfectly air-tight, containing a worm formed of a copper tube, the two ends of which project outside the apparatus. In this cylinder, and upon the worm itself, is effected, by means of a cock of special construction, the release of the ethylene previously condensed in a metallic receiver. Two tubes of copper, secured by screws, penetrate into the cylinder. One of these tubes is in communication with the suction-valve of the author's mercurial pump, which acts as a pneumatic machine, giving a vacuum almost absolute. The second tube receives the ethylene compressed by the pump and brings it, refrigerated by methyl-chloride, above the releasing-cock.

Electro-Chemical Energy of Light.—F. Griveaux.—The author substitutes the measurements of the electro-motive forces developed for that of the intensity of the currents produced. His researches have been directed to the following points:—(1.) Given the same plate and the same luminous source, what is the influence of the distance between them? The comparison of the sources as to their illuminating power and their electro-chemical energy. (2.) Influence of the superficial extent of the sensitive plate. (3.) Influence of the thickness of the layer of the salt of silver. (4.) Effects produced by the same quantity of light falling upon plates of different extent, but prepared identically. (5.) Influence of the nature of the light. The relation between the electro-motive force developed and the wave-length of the simple light employed. The numerical results will be communicated in a future memoir.

Action of Carbonic Acid upon Calcareous Saccharine Solutions.—D. Loiseau.—The presence of calcium carbonate in a solution opposes the precipitation of the saccharates of the same base. The saccharate and the carbonate keep each other mutually in solution.

A New Ureometer.—W. H. Greene.—The author describes and figures a new apparatus for the rapid approximate determination of urea in urine.

Biedermann's Central-Blatt für Agrikultur-Chemie,
Vol. xii., Part 10.

Examination of Corpuscles suspended in Water.—E. Marchand.—From the *Comptes Rendus*.

Influence of the Salts of Sea-water upon Fresh-water Animals, and Cause of the Death of Fresh-water Animals in Sea-water and of Sea-water Animals in Fresh-water.—H. de Varigny and P. Bert.—From the *Comptes Rendus*.

Researches on Different Kinds of Humoid Soils and on their Behaviour with Water.—Prof. A. Emmerling.—An examination of three specimens of moorland soils.

Proportion of Carbonic Acid in the Atmosphere.—A. Muntz and E. Aubin.—The substance of this paper has appeared in the *Comptes Rendus*, vol. xcvi., p. 1796.

Manurial Value of Dried Blood.—Prof. A. Petermann.—Dried blood was tried in comparison with doses of soda saltpetre containing approximately equal quantities of nitrogen, alone, along with phosphoric acid, and again along with phosphoric acid and potash. The experiments were performed both on sandy and clayey soils. The value of the dried blood was found less than that of soda saltpetre, both when used alone, and when applied conjointly with phosphoric acid and potash. The sources of nitrogen appear to hold the following positions in respect to their efficacy. Soda saltpetre, dried blood, dissolved wool, crude wool, and ground leather.

Manurial Experiments upon Potatoes, Beets, and Maize.—A. Nantier.—With potatoes, the author finds that superphosphate and precipitated phosphate were most efficacious in increasing the yield. Upon beets the action of precipitated phosphate was in every respect more beneficial than that of superphosphate. Maize seemed to derive the greatest benefit from farm-yard manure.

Manurial Experiments at Löwitz.—Count Von Schwerin.—Organic nitrogen was found much less efficacious than soda saltpetre.

Experiments on Four-Years' Rotation.—Dr. A. Voelcker.—From the *Journal of the Royal Agricultural Society*.

A Silesian Farm without Cattle.—M. Fischer.—The author finds the exclusive use of artificial manures more advantageous and more effectual, except for rape.

Chemistry of Glutine.—H. Weiske.—Collagen is the more readily converted into glutine the poorer it is in mineral matters. If such substances are completely removed, a solution of glutine is obtained, which, unlike ordinary glutine, is not precipitated by tannin unless a few drops of a solution of sodium chloride are simultaneously added.

Experiments and Observations on Various Diseases of Cattle.—A summary of the results of Pasteur and others on rabies and on protective inoculation in case of sheep-pox and pleuro-pneumonia.

Value of Wheat-bran for Human Diet.—Dr. Max Rübner.—The finest flour represents only 30 per cent of the grain of wheat; the medium qualities about 70 per cent. Comparative experiments were tried with bread made respectively from such flours and from the wheat-meal of the Bread Reform League. The larger the proportion of bran left in the flour the more nutritious matter remains unassimilated, and is excreted. The author considers that bran might be made more assimilable by being more finely ground. He doubts, however, the economy of the proposal, since at present bran serves for the food of animals which are able to digest and assimilate it much more completely.

Studies on Milk.—H. Struve.—From the *Journal für Praktische Chemie*.

Effects of Cotton Seed Cake upon the Yield of Milk.—The result of the experiments made upon six cows showed an advantage in the use of the cake.

Influence of Radiant Heat upon Parts of Plants during Growth.—J. Wortmann.—Curvatures may be induced in growing plants by the influence of radiant heat applied unilaterally, the inclination being sometimes towards, sometimes away from, the source of heat.

Artificial Modification of Internal Causes of Growth.—Prof. E. Wollny.—These two papers do not admit of useful abstraction.

Sequel to Studies on Evaporation.—Dr. Paul Sorauer.

Composition of the Barley produced in the Province of Saxony.—Prof. Mærcker.—The value of the Saxon barley for brewing purposes is ascribed to its small proportion of nitrogenous compounds.

Justus Liebig's Annalen der Chemie,
Band 220, Part 3.

Communications from the Chemical Institute of Marburg.—These consist of a paper by Paul Senff on meta-benzyl-toluol, meta-tolyl-phenyl-keton, meta-benzoyl-benzoic acid, and their reduction-products; a memoir by W. Roser, on terebic acid, and another by the same author, on iso-propyl-succinic acid or pimelic acid.

Gluconic Acids of Different Origin.—A. Herzfeld.—The author's immediate object is to ascertain if the gluconic acid from maltose is identical with the dextronic or gluconic acid of Hlasiwetz and Habermann. He concludes that dextronic, maltonic, and gluconic acids are identical. It is indifferent whether bromine or chlorine is used for the preparation of gluconic acid, and likewise if silver oxide or another metallic oxide or carbonate is used for the decomposition of the halogen compound. The gluconic acid obtained is always the same. On oxidation with bromine saccharic acid always appears along with gluconic acid. Gluconic acid does not reduce Fehling's solution; it is mono-basic.

Remarks on Benzo-quinone.—O. Hesse.—The author opposes the view of Scheid that benzo-quinone contains a hydroxyl.

Vol. 221, Part 1.

Different Chemical Behaviour of the Aromatic Diamines.—Eugen Lellmann.—The author first describes the preparation of the diamines, and then proceeds to consider the behaviour of the sulphocyanides of the aromatic diamines, of the corresponding cyanates, the reduction of the ortho-nitrised anilides and toluides of benzol-sulphonic acid, and the action of the mustard oils upon the diamines.

Communications from the Chemical Laboratory of the University of Jena.—These consist of a memoir by Dr. Max Schroeder on the action of carbon monoxide in presence of salts whose acids belong to different series; a paper by A. Geuther on the action of phosphorus trisulphide upon phenol and cresol, and an essay by the same author upon certain new derivatives of mannite.

Examination of Saturated and Non-saturated Esters and Certain Allied Compounds.—F. Veger.—This paper does not admit of useful abstraction.

The Chemical Affinity of Certain Groups of Compounds deduced from their Density, and the Changes in Volume on the Neutralisation of Aqueous Solutions.—W. Müller-Erbach.—Judging from the density of the compounds, phosphorus, boron, and silicon have a greater affinity for chlorine than for bromine. In accordance with relations of volume, and in accordance with the known behaviour of the compounds, we find the affinity of chlorine decidedly feeble than that of iodine. Potassa and soda, when neutralised with nitric, sulphuric, and hydrochloric acids, undergo a contraction which is masked by the presence of large quantities of water, and converted into expansion.

Chloride of Lime and Chloride of Lithia.—K. Kraut.—A reply to Dr. G. Lunge's memoir published in Vol. 219, p. 129, of these *Annalen*. The author discusses Dr. Lunge's paper at considerable length, and gives in conclusion his own view. He considers chloride of lime as a mixture of equal mols. of calcium chloride and hypochlorite. The third mol. of lime unites with one of these salts to form a basic salt, the formation of which is the cause that not 6, but only 4, atoms of chlorine act upon 3 mols. of hydrate of lime.

Vol. 221, Part 2,

Certain Bromine Substitution Products of Ethane and Ethylene.—R. Anschütz.—The results of the author's studies on the bromised ethane and ethylenes may be summarised as follows:—Dibromethylene, in which Demole observed conversion into brom-acetyl-bromide by the direct addition of oxygen, has an unsymmetric formula, and is acetylen-dibromide. There are known at present only two isomeric tetra-brom-ethane, which are clearly distinguished from each other by their physical properties. Their boiling-points and specific gravities differ when determined under identical circumstances. Only the non-symmetric halogen derivatives of ethane, ethylene, and acetylene seem to exhibit phenomena of polymerisation. Between any two bromised ethane the difference of the boiling-points is the same as between the two corresponding bromised ethylenes. Among the isomeric bromised ethane and ethylenes, the non-symmetric compound has a lower specific gravity than the symmetric. The specific gravities of the bromised ethane are smaller than those of the corresponding ethylene compounds.

Meta-iso-cymidine.—Werner Kelbe and Constantine Warth.—The authors describe nitro-meta-iso-cymol, its oxidation, the formation of nitro-toluylic acid, and the barium salt of the latter; meta-iso-cymidine, its sulphate, oxalate, and platinum double salt; acet-meta-iso-cymidide, nitro-benzoyl-meta-iso-cymidide, benzoyl-iso-cymidide; the oxidation of benzoyl-meta-iso-cymidide, meta-iso-cymidine, its oxidation to amido-meta-toluylic acid; phthal-meta-iso-cymidide, nitro-phthal-meta-iso-cymidide, meta-iso-cyminy-carbyl-amine; certain substituted ureas such as meta-iso-cyminy-urea, the corresponding di-compound, meta-iso-cyminy-urethan, di-meta-iso-cyminy-thio-urea, meta-iso-cyminy-ethyl-thio-urea, meta-iso-cyminy-ethyl-guanidine, tri-benzoyl-meta-iso-cyminy-ethyl-guanidine, nitro-meta-iso-cymidine, sulpho-meta-iso-cymidic acid, and its barium salt.

Communications from the Chemical Laboratory at Greifswald.—These consist of a memoir by Dr. O. Kornatzki on certain di-sulpho-azo-toluic acids, and on a para-di-sulpho-toluic acid; a paper by H. Limpricht on the behaviour of the amides of certain sulpho-acids with nitrous acid. This subject is worked out by F. Hybbeneth as regards the amide of meta-sulpho-amido-benzolic acid; by Dr. A. Heffter for the amide of ortho-sulpho-para-amido-toluic acid, and by W. Paysan for the amide of para-sulpho-ortho-amido-toluic acid. Lastly follows a memoir by G. Mohr on benzyl-sulphonic acid.

Carboxy-tartronic Acid and the Constitution of Benzol.—Aug. Kekulé.—A voluminous defence of the author's views on the constitution of benzol.

MISCELLANEOUS.

Erratum.—In the continuation of Mr G. Stillingfleet Johnson's article on "Electro-Chemical Researches on Nitrogen" (vol. xlviii., p. 264), Fig. 5 should be Fig. 3, Fig 3 should be Fig. 4, and Fig. 4 should be Fig. 5.

New Views of Chemical Philosophy.—Professor J. P. Cooke, of Cambridge, commenting upon some views recently expressed by Boutlerow, the eminent chemist (which views relate to the variability of the law of definite proportions, and which are endorsed by Schutzenberger), remarks:—"Such opinions are certainly very revolutionary, and, if they prevail, must entirely change the fundamental conceptions of chemical philosophy. Chemical combination can no longer be regarded as the juxtaposition of the definite invariable masses we call atoms, but must be considered as the "reciprocal saturation," or "interpenetration," of masses which may vary with the relative strength of their chemical energy acting at the time; and this change of the fundamental conception is

inconsistent with the atomic theory and with the super-structure which modern chemistry has built upon it." Boutlerow claims that his views are new, or, rather, he asserts that he has held them for a period of three years. There is, in fact, nothing new about them; for it is well-known among chemists in this country, that Cooke not only expressed these views twenty-five years ago, but he worked them out in the laboratory, and presented to the American Academy in 1855 memoirs which fully developed all that is now claimed as new by the German chemist. The paper published by Cooke "On Two New Crystalline Compounds of Zinc and Antimony, and on the Cause of the Variation of Composition observed in their Crystals," goes over the whole ground, and calls attention to the order of variation in the composition of certain well-defined crystals obtained from alloys of zinc and antimony, of different percentage composition, by the method of "fusion." It is difficult to understand how so well-informed and painstaking a chemist as Boutlerow could have overlooked Professor Cooke's researches. He is certainly anticipated in his discoveries by at least twenty years, and it becomes him to place himself in rightful position. The extended and careful researches of Professor Cooke do not lead him to doubt the correctness of the atomic theory; and the assumption of the existence of molecules and atoms forms an hypothesis upon which all the perplexing phenomena observed can be explained. The variation in the proportions of constituents of a crystallised compound without any change in the crystalline form, he proposes to designate as examples of "allomerism." Probably no investigator in the past quarter of a century has conducted so elaborate a series of experiments, with the view of proving or disproving the correctness of the atomic weights, as Professor Cooke, and this line of difficult research is still in progress at the Cambridge laboratory. He states that he has found no problem of chemistry more difficult than to prove that the materials and products involved in atomic weight determinations are perfectly pure, and represent a condition in which the elements are united in the definite proportions sought. The weight of evidence is at present in favour of the atomic theory; but we must not forget that chemical philosophy as now understood does not rest upon the impregnable basis of demonstrated fact. Professor Cooke is forced to admit, that while he regards the weight of evidence in favour of the atomic theory, and that it is the only basis on which a consistent philosophy of chemistry can at present be built, still he is rather drawn to that view of nature which refers all differences between substances to dynamical causes, and which regards the atomic theory as only a temporary expedient for representing the facts of chemistry to the mind. This is essentially the view of most of the able chemists now living, and it leads irresistibly to the conclusion that the mysteries surrounding what we call matter are as impenetrable as those connected with mind, soul, or spirit.—*Popular Science News.*

MEETINGS FOR THE WEEK

- MONDAY, Dec. 17th.—Medical, 8.30.
 — London Institution, 5.
 — Society of Arts, 8. "The Scientific Basis of Cookery," By W. Mattieu Williams, F.C.S.
- TUESDAY, 18th.—Institute of Civil Engineers, 8. (Anniversary.)
 — Pathological, 8.30
- WEDNESDAY, 19th.—Society of Arts, 8. "Canada and its Products," by the Most Hon. the Marquis of Lorne, Kt., late Governor-General of Canada.
 — Meteorological, 7.
 — Geological, 8.
- THURSDAY, 20th.—Royal, 4.30.
 — London Institution, 7.
 — Chemical, 8. "Researches on the Constitution of the Gums of the Arabin Class," by C. O'Sullivan. "On the Decomposition of Ammonia by Heat," by Dr. W. Ramsay and Sydney Young. "On the Dissociation of the Halogen Compounds of Selenium," by Dr. W. Ramsay and F. P. Evans.

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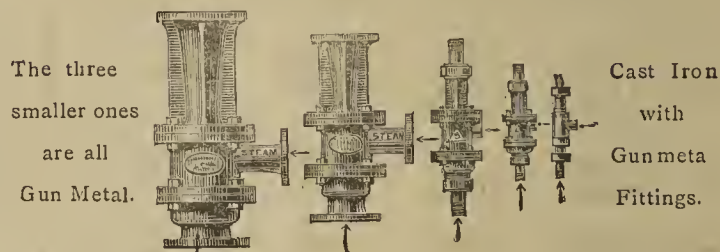
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THE CHEMICAL NEWS.

VOL. XLVIII. No. 1256.

THE WAVE-LENGTHS OF A, α , AND OTHER PROMINENT LINES IN RED AND INFRA-RED OF THE VISIBLE SPECTRUM.*

By Captain ABNEY, R.E., F.R.S.

M. FIEVEZ has recently sent me a map of the solar spectrum from C to A† inclusive, and as part of this region is one which I am measuring for a new photographic map of the whole solar spectrum in conjunction with Professor Rowland, I have examined the new publication with great interest. Photography and eye measurements do not exactly coincide in the detail of the grouping of the little α group as far as A, and A itself is shown by M. Fievez's map as wanting in some details which appear in the photographs. Thus in the photographs there are some nineteen lines, whilst in M. Fievez's map there are but thirteen. Between A and α there are several lines of marked intensity in the photograph which are not shown in the new map. The wave-lengths of the different lines from above " α " to A are not those given by Fievez, when comparison photographs of the first order of the red and second of the ultra-violet were taken on the same plate, which were again checked by photographs of the second order of the red with the third order of the green taken in a similar manner. In my Bakerian Lecture for 1880 on the "Photographic Method of Mapping the Least Refrangible End of the Spectrum," I gave a method of using mirrors by which this could be effected, but since Prof. Rowland introduced his concave gratings this is much more readily carried out. He has kindly furnished me gratings for the purpose, and having about 14,400 lines to the inch, with focal distances of 7 feet 6 inches and 12 ft. 6 ins. respectively. These have been employed in determining the wave-lengths of this part of the spectrum. Cornu's map was used as a reference for the ultra-violet wave-lengths, and Angström's map for those in the blue and green.

Descript'n of line.	λ from compar'n. of 1st and 2nd orders.	λ from compar'n. of 2nd and 3rd orders.	λ according to Fievez.	Remarks.
" α "	{ 7184'4 7185'4	{ 7184'5 7185'4	{ 7197'7 7198'7	{ This is shown in Angström's map as a single line λ 7184'9.
Most refrangible edge of A.	7593'6	7593'7	7600'0	Angström gives 7604 for the centre of this line; which of the bands he took as A is not clear. Langley gave 7600'9 for this edge.
Centre of 6th pair of lines in the flutings following A.	7644'2	7644'33	7652'2	

The determination of A has been made by Mascart, Smythe, and others, besides Angström and Langley, with discordant results. I think the above may be taken as accurate as are Cornu's and Angström's maps.

It may be useful to forestall the map by giving the wave-lengths of a few of the principal lines in the infra-red. The first four have been seen and measured by Professor Piazzi Smyth. The scale-numbers refer to my map of the infra-red, which is published in the *Phil. Trans.*, Part II., 1880.

Scale No.	Description.	Wave-lengths.
1046	This line is a double, of which the components have the accompanying wave-lengths..	{ 8226'4 8229'9 }
1441	.....	8496'8
1509	.....	8540'6
1685	.....	8661'0
2175	A double line, the components of which have the accompanying wave-lengths	{ 8986'2 8989'5 }
2638	" " "	{ 9494'5 9500'1 }
3161	.....	9633'8

The measurements of the lines have been made with a micrometer by Hilger. The $\frac{1}{100000}$ of an inch can be easily measured, and in extreme cases the $\frac{1}{100000}$ of an inch can be recognised.

LEAD-CHAMBER DEPOSIT FROM THE BRIMSTONE SULPHURIC ACID OF JAPAN.*

By EDWARD DIVERS, M.D., and MASACHIKA SHIMOSÉ.

SULPHURIC acid is made in Japan exclusively from brimstone or volcanic sulphur, no pyrites or sulphur prepared from it being employed.

The deposit we received from the sulphuric acid works of the Imperial Japanese Mint at Osaka, had been cleaned out of the lead chambers in the form of a slime or mud. It settled on standing into a pale yellow, supernatant liquor, and a sediment of grey-red colour with many bright yellow particles. The liquor was sulphuric acid, impure, and very dilute, of sp. gr. 1'15. Its colour was due to ferric sulphate present in not inconsiderable quantity. We obtained from 1 litre of the liquor:—

Tellurium	.. .. .	0'37 grm.
Selenium	.. .. .	0'15 "

and also a trace of arsenic.

The sediment drained of its mother-liquor as far as practicable upon a filter, and dried in the sun without previous washing, weighed two-thirds of the whole deposit. It was in this state analysed to the extent shown by the subjoined table:—

Selenium, free and combined	.. .. .	10'5
Tellurium, " "	.. .. .	1'2
Sulphur, uncombined	.. .. .	6'5
Arsenic	.. .. .	doubtful trace
Mercury, uncombined	.. .. .	0'016
Copper	.. .. .	trace
Molybdenum	.. .. .	trace
Lead sulphate	.. .. .	29'5
Silicious ash and earthy matters	.. .. .	24'5
Hydrogen sulphate	} by diff.	27'8
Water, principally		
Organic matter, a little		
Ferric sulphate, a very little		

100'016

The proportions of selenium and tellurium in acid liquor and sediment were, as will be seen, reversed. The cause of this was the oxidisability of moist, finely-divided tellurium by air, particularly in the presence of an acid.

* Communicated by the authors. Some of the facts described in this paper have been made known already at meetings of the British Association.

* A Paper read before the Royal Society, December 6, 1883.

† *Annales de l'Observatoire Royal de Bruxelles, nouvelle série, t. v.*

Selenium is affected in the same way to only a very slight extent. The fact of the ready oxidisability of tellurium we have ascertained by experiments, both with the deposit itself and with pure tellurium. It is also mentioned by Kastner. The deposit when we obtained it had suffered much exposure, and we believe that we should have found in it, if it had not been thus exposed, much more tellurium than we did.

When the sediment was distilled in a clay retort, there came over at first much water and sulphur dioxide, next a bright yellow sublimate in small quantity, apparently impure sulphur; then much selenium and tellurium; and, lastly, selenious oxide—sulphur dioxide escaping all along. Somewhat unexpectedly the whole of the tellurium came over, as well as all the selenium. The retort contained, among the other fixed matters at a distance from its hot sides, some very well crystallised galena, formed by the reducing action of the sulphur and selenium upon the lead sulphate.

The composition of this deposit is remarkable for several of its details. Taking the presence of *ten per cent of selenium* first, this selenium is in itself common enough in deposits from chambers making vitriol from Harz pyrites (Lunge), and even in such quantity, but it is here peculiar in being present in a deposit in chambers fed with nothing but brimstone gas.

Tellurium has not previously been found at all in lead chambers. We announced in 1881 (*CHEMICAL NEWS*, vol. xlv., p. 229), the occurrence of tellurium in Japanese sulphuric acid, then found we believe for the first time in any sulphuric acid.

Mercury, as a constituent of the deposit in chambers where Harz pyrites is burnt, is incidentally noticed in Lunge's "Sulphuric Acid," pp. 584-5, when Otto's process for getting selenium from the deposit is described. But here, as remarked of the presence of selenium, there is the peculiarity of its occurring where only brimstone—volcanic sulphur—is employed. All the attempts that we have had made to detect mercury in volcanic sulphur from different localities in Japan, have been unsuccessful. We included in our examination, samples of the sulphur in use at the works, which was not, however, part of any stock long in use there, and consequently not with certainty of exactly the same kind as that burning when the mercury had been deposited. In testing for mercury in the sulphur we used such quantities as 20 grms., dissolved in potassium hydroxide, and oxidised by chlorine. We are indebted for part of this testing to Mr. Iwaichiro Shidzuki, and also for the estimation of the mercury in the chamber deposit. Our assertion that the mercury was in the uncombined condition is based upon the fact that whereas the deposit readily gave up the mercury to dilute nitric acid, it entirely refused to do so to potassium cyanide solution.

Copper is so common that the trace of it found in the deposit is perhaps not so remarkable as that of mercury.

Molybdenum is here found in chamber mud probably for the first time, and is remarkable for being present under the circumstances. We obtained a little burner-ash, and found in it some molybdenum oxide and a very small quantity of tellurium oxide. The ash was a soft, light, pale yellowish grey substance.

The sulphur present in the elemental state was not intimately diffused through the deposit, but formed very distinct pellicular particles of a bright orange-yellow colour. Its colour was due no doubt to the presence of selenium and tellurium in combination with it, and its form seemed to have resulted from the tearing up of a film.

The sediment readily, though very imperfectly, sorted itself on elutriation into lead sulphate, grey and slimy, at the bottom; coarse, whitish, friable particles of ash and particles of sulphur next; and, at the top, exceedingly fine particles of red impure selenium.

We have had many gallons of the mud in our possession, and know, therefore, that our examination has not

been made upon some specially selected part of the chamber deposit that might have excited attention by its colour.

Imperial Japanese College of Engineering,
Tokio, November 5, 1883.

THE RED SULPHUR OF JAPAN.*

By EDWARD DIVERS, M.D., and TETSUKICHI SHIMIDZU, M.E.

THERE has long been recognised in Japan, as being distinct from ordinary sulphur, a full orange-red variety under the name of *seki-rin-seki* (massive red sulphur). It is allied to the selen-sulphur of the Lipari Islands (Stromeyer), Naples (Phipson), and Hawaii (Dana), but differs from it in composition. The specimen we examined had the following composition:—

Tellurium	0.17
Selenium	0.06
Arsenic	0.01
Molybdenum	trace
Earthy matter	trace
Sulphur, by diff., nearly	99.76

100.00

When the tellurium sulphur was treated with carbon bisulphide, the arsenic remained as sulphide.

Red or tellurium sulphur appears to be found among all the deposits of volcanic sulphur in Japan. We have obtained it from Iwoshima and Motoyama, Satsuma, and Tateyama, Etchuu. We have also seen some said to have come from Oshima.

The yellow sulphur usually associated with the red sometimes contains traces of tellurium and selenium. The two sulphurs form a striking contrast in colour.

THE BEHAVIOUR OF SILVER CHLORIDE BROMIDE, AND IODIDE WITH BROMINE AND IODINE.

By PAUL JULIUS.

IN order to avoid the use of thallous or palladious oxide in the determination of iodine in presence of chlorine and bromine, in the expectation that, as commonly assumed, silver iodide would be completely converted into bromide, the chloride remaining unchanged, there was passed over silver iodide, and over mixtures of iodide and bromide, vapour of bromine, the substances being kept for ten minutes in a state of fusion.

Through a tube, bent at right angles, there was passed a current of air, previously dried by means of sulphuric acid and calcium chloride, into bromine contained in a small Hofmann's flask.

The air, saturated with bromine vapours, passes thence into a horizontal tube of very infusible gas, containing the substance to be acted upon. At its opposite end this tube is bent down at right angles and somewhat contracted, and passes into a beaker containing potassa or soda. The part of the tube containing the substance is strongly heated by means of a compound Bunsen of four jets. In this manner bromine can be accurately determined in pressure of iodine, as the conversion of silver iodide into bromide is easy and complete.

Silver chloride, previously dried in the air-bath at 120°, was then treated in the same manner with vapours of bromine. After the action had been continued for 1 to 2

* Communicated by the authors. Partly described already at a meeting of the British Association.

hours it was found that all the silver chloride had been converted into bromide.

By further experiments it was proved that chlorine and bromine can be expelled from their silver-compounds by the vapour of iodine, though in case of the chloride this substitution requires from 6 to 10 hours. Hence, any halogen, if applied in excess, is capable of expelling any other halogen from its combination with silver.—*Zeitschrift für Anal. Chemie.*

DETERMINATION OF SULPHUR IN PYRITES.

By G. LUNGE and C. BODEWIG.

G. LUNGE has undertaken experiments to ascertain whether in the aqua-regia used for dissolving pyrites in the moist way there is any advantage in the use of a nitric acid of very great strength. He finds that it is not advisable to take a nitric acid of a specific gravity exceeding 1.42.

Bodewig effects the opening up of pyrites as follows:—

About 0.5 grm. of the sample is introduced into a stoppered flask containing about 30 c.c., about 30 c.c. of water are added, and the necessary quantity of bromine, about 4 c.c. is introduced *at once*. If the bromine is added gradually, sulphuretted hydrogen escapes. The flask is immediately stoppered and shaken for 5 minutes. There is scarcely any heat evolved. The oxidation is complete when all the bromine has passed into solution, and when no pulverulent sulphur creeps up the sides of the flask. The liquid is rinsed into a flat porcelain dish, the greater part of the bromine is allowed to evaporate in the cold; the solution is neutralised in a beaker with ammonia, but not so as to form a permanent precipitate; it is then poured into an excess of hot ammonia in a platinum capsule and digested for 10 to 15 minutes over a small flame. Hereupon it is filtered, the filtrate is slightly acidified with hydrochloric acid, the hot diluted solution is precipitated with barium chloride, and the barium sulphate is purified and weighed in the ordinary manner.

Iron cannot be determined in the same portion, as it is volatilised even in the cold along with the vapours of bromine.—*Zeitschrift für Anal. Chemie.*

ON SOME PHOSPHIDES OF IRIDIUM AND PLATINUM.

By F. W. CLARKE and O. T. JOSLIN.

In May, 1881, Mr. John Holland, a manufacturer of gold pens in Cincinnati, took out a patent for a process of fusing iridosmine. For pointing gold pens, only selected grains of the native mineral were suitable; and his object was to utilise the quantities of unavailable mineral which accumulated in his establishment. His process, briefly stated, consisted of heating the ore to whiteness, and then throwing in upon it common phosphorus; fusion at once took place, and the excess of phosphorus was afterwards removed by heating the product in contact with lime. The metal thus produced was harder than steel, brilliantly lustrous, insoluble in acids, and available for a great variety of purposes. As the process has already been fully described by Professor W. L. Dudley,* it needs no further technical discussion here. Our work relates to the chemical side of the new iridium industry.

At an early date, samples of the "fused iridium" were placed in our hands for examination, together with some of the original ore from which the melts had been made. The latter was a Californian iridosmine, in hard, brilliant grains, of specific gravity 19.182. Of the fused product the sp. gr. was only 13.768.

Two portions of the latter were prepared at different times for comparison with the native mineral, and partial analyses were made. In the first portion, phosphorus only was determined, three estimations giving respectively 7.52, 7.58, and 7.74 per cent. This portion contained barely a trace of osmium.

In the iridosmine itself 15.38 per cent of osmium were found; and accordingly the second fused portion was examined with special reference to this element. As far as it was carried out, the analysis gave the following results:—

Iridium	80.82
Osmium.. .. .	6.95
Phosphorus	7.09
Ruthenium and rhodium	7.20
	<hr/>
	102.06

No attempt was made to separate the ruthenium and rhodium, nor to trace out the cause of the plus error. The phosphorus agrees reasonably well with the estimations made in the first portion; and the low percentage for osmium, compared with the mere trace in the other lot and the large amount in the ore, shows that this element is more or less eliminated according to the circumstances attending fusing. The "fused iridium" is plainly, as might be expected, a phosphide; and the percentage of phosphorus indicates a compound having the formula Ir_2P . For this formula the percentage of phosphorus should be 7.43, and evidence in its favour will appear farther on. Of course the product is far from pure, containing the phosphides of the other metals of the group; but its general nature is evident. With pure iridium as the starting point, a pure Ir_2P would probably be obtained.

Since it seemed desirable to ascertain how platinum would behave when treated like the iridium, experiments in that direction were undertaken. The metal used was a worn out platinum crucible, carefully cleaned, of which a sample was first analysed. The results were as follows:—

Platinum	97.22
Iridium	2.49
Copper	0.46
Palladium	a trace
	<hr/>
	100.17

15.4200 grms. of this material were heated to whiteness in a Hessian crucible, and 20 grms. of stick phosphorus were thrown in. Fusion at once took place, and when the excess of phosphorus had burned off, the mass was allowed to cool. We thus obtained a brilliant silver white, brittle button, weighing 19.4663 grms. As it was porous, we did not determine its specific gravity. If we reckon the iridium in the mass as platinum, and ignore the trifling amount of copper, the increase in weight gives us synthetically the following composition for the product:—

	Found.	Calculated for Pt_3P_8 .
Platinum	79.21	79.05
Phosphorus	20.79	20.95
	<hr/>	<hr/>
	100.00	100.00

These figures are useful only in confirmation of our subsequent analyses.

A portion of the phosphide, coarsely powdered, was next boiled for at least forty hours with aqua regia. At the end of that time a considerable portion was still undissolved, and trial showed it to be quite insoluble in the reagent. The soluble portion amounted to 71.21 per cent of the whole, and the insoluble part to 28.79 per cent. The latter, dissolved by fusion with sodium nitrate and caustic soda and subsequent boiling with aqua regia, was analysed separately, and proved to be a definite phosphide of the formula PtP .

* *Sci. Proc. Ohio Mechanics' Institute, Jan., 1882.*

	Found.	Calculated for PtP
Platinum	86.16	86.28
Phosphorus	14.03	13.72
	100.19	100.00

The soluble fraction, also analysed independently, agreed approximately with the formula PtP_2 .

	Found.	Calculated for PtP_2 .
Platinum	76.62	75.88
Phosphorus	23.68	24.12
	100.30	100.00

Re-calculating the analyses of the two fractions so as to express the composition of the original phosphide, we get the following results to compare with those obtained by synthesis:—

	Found, Analysis.	Found, Synthesis.	Calculated for Pt_3P_5 .
Pt . . .	79.39	79.21	79.05
P . . .	20.87	20.79	20.95
	100.26	100.00	100.00

The data for the foregoing calculations, in weights, are as follows:—Weight of sample, 2.2042 grms. Dissolved, 1.5695 grm.; undissolved, 0.6347 grm. Platinum in the soluble portion, 1.2025 grms.; in the insoluble, 0.5475 grm.; total, 1.7500. Phosphorus in the soluble portion (calculated from weight of $\text{Mg}_2\text{P}_2\text{O}_7$), 0.3717 grm.; in the insoluble, 0.0891 grm.; total, 0.4608 grm. These figures further show that the ratio between the dissolved and insoluble phosphides agrees well with the equation $\text{Pt}_3\text{P}_5 = \text{PtP} + 2\text{PtP}_2$:

	Found.	Calculated.
Insoluble PtP . . .	28.79	30.54
Soluble PtP_2 . . .	71.21	69.46
	100.00	100.00

The slight discordance here, 1.75 per cent, taken together with the fact that the platinum in the soluble part came out rather too high, shows that a trifling quantity of the PtP was dissolved by the very prolonged action of the aqua regia to which it had been subjected. In other words, the fractionation of the Pt_3P_5 into the two similar phosphides is not quite perfect.

In order to determine whether the complex phosphide Pt_3P_5 could be reduced to metal by long heating, two portions were roasted in a muffle until constant weight was obtained. The losses in weight were 14.08 and 13.78 per cent. respectively. The product of this roasting was malleable, and readily soluble in aqua regia. It contained 7.36 per cent. of phosphorus, which is just the amount required by the formula Pt_2P . Here then we have a fourth phosphide analogous in composition to the fused iridium, and confirmatory of the formula assigned to the latter. The reduction of Pt_3P_5 to Pt_2P should require a loss of 14.66 per cent. In all of these calculations we have taken 195 for the atomic weight of platinum. The trace of copper in the original platinum did not show itself in any of the analyses of the phosphides, and the small amount of iridium present could nowhere affect our results by more than a hundredth of a per cent.

In conclusion, our experiments show the existence of three simple phosphides of platinum, PtP_2 , PtP , and Pt_2P , and of a double phosphide, Pt_3P_5 . Of these compounds the monophosphide, by virtue of its insolubility in aqua regia, is the most noteworthy. The compound PtP_2 is probably identical with the phosphide described by Schrötter,* who obtained it, as well as analogous phosphides of iridium and palladium, by heating the finely divided metal in phosphorus vapour. As far as we can learn, no other platinum phosphides have ever been

regularly analysed. Pelletier* heated platinum with phosphorus and found that 300 grains of the former took up 54 of the latter; results which approximate roughly to the ratio PtP . Edmund Davy† tried two sets of experiments in the same direction. First, he heated ammonium chloroplatinate with phosphorus, and obtained a black compound of doubtful composition. Afterwards he heated platinum and phosphorus together in a vacuum, and obtained results which, calculated synthetically, agree well with the formula Pt_3P_4 . This product was insoluble in strong acids, and at the time (1812) could not be directly analysed.—*American Chemical Journal*.

ON THE USE OF MERCURY THERMOMETERS, WITH PARTICULAR REFERENCE TO THE DETERMINATION OF MELTING- AND BOILING-POINTS.

By J. M. CRAFTS.

THE progress made during the last twenty years in the preparation and purification of chemical substances has not been followed by a corresponding improvement in the methods which serve to determine some of their physical properties, and this is particularly true of determinations involving the measure of temperature.

The methods used for the graduation of thermometers are often unreliable, the modes of reading them give varying results, and the ordinary tables of corrections contain errors much greater than those which it is intended to correct.

A series of experiments‡ was undertaken with a view to remedying some of these defects by processes which can be easily carried out in a chemical laboratory, and they were extended to an examination of the best methods of manufacturing nearly accurate thermometers, after it was discovered that the principal defects can be remedied by means easily within the reach of a careful instrument-maker. In fact, the methods of preparation and of graduation of thermometers for higher temperatures, which will be proposed, are similar to the processes now in use for pointing the scale between zero and 100°; and it is hoped that they will insure nearly as great accuracy for the temperatures between 100° and 360° as is now obtained with normal thermometers between zero and 100°.

The different sources of error in the kind of thermometric observations that we are considering will be examined in detail.

Mercury Thermometers.—The Calibration.

The standard thermometers made at the observatory at Kew, and those of M. Baudin, of Paris, are calibrated before graduation in order that the stem may be divided into parts of equal capacities, and a subsequent calibration made with the best apparatus shows residual errors of 0.015° to 0.04°, when the scale is divided in tenths of a degree. The process of correction of the errors of calibration and graduation attains an exactitude 0.002°.||

Thermometers made with extraordinary care, and divided into 500 parts between zero and 100°, or into 360°

* *Ann. de Chimie*, 13, 1792, 101—143.

† *Tilloch's Mag.*, 40, 1812, 27—39. *Schweigg. Journ.*, 10, 382.

‡ Some of the experiments described in this paper have been published in the *Comptes Rendus*, xci., 291, 370, 413, and 574; xciv., 1299; and xev., 836 and 910. The theoretical considerations of the articles in the *Comptes Rendus* are here omitted, and a greater development is given to the practical directions concerning laboratory operations. The table of corrections for thermometers with a limited scale has been added.

|| M. Pernet, of the International Bureau of Weights and Measures at Sèvres, has had the kindness to furnish the details regarding the calibration of standard thermometers.

for the complete scale, are found to have a mean error not greater than one-third of a division.

The thermometers ordinarily used in chemical laboratories are far from being equally exact; for instance, 19 French and German thermometers were found to have differences of 0.1° to 0.5° in the length of contiguous sections of 25° . If the tube is regularly conical these differences are cumulative; thus an error of 3.6° at 230° was found in calibrating a thermometer of this kind (the value of the degree between zero and 100° was taken as unity).

Most frequently the variations in the length of a column have sometimes a plus, sometimes a minus sign, but these errors do not usually cancel each other, and it is rare to find ordinary thermometers which do not require at several parts of their scale corrections for errors of calibration amounting to a large fraction of a degree; hence for accurate work the thermometer should be calibrated according to one of the methods described in physical text-books.

It is impossible by the ordinary processes to calibrate the thermometers intended for use at high temperatures, when the tube contains air; but the following method gives a sufficiently exact calibration when the upper reservoir is large enough to contain at least 1-10th of the mercury of the bulb. The bulb is heated until part of the mercury rises into the reservoir and there a globule is separated by a jerk, and by trial a sufficient quantity is detached to make a column of 20° to 30° . The thermometer is allowed to cool in such a manner that this small column follows the mercury in the stem with an interval of 10° to 30° , which space is necessarily filled with air. On account of the air it is impossible by the usual method to change at will the position of the separated column; it follows the main body of the mercury, but it may be fixed without great difficulty at the required points by heating the bulb to temperatures which must remain constant during each observation of the length of the small column. For this purpose a very simple thermostat is employed, consisting of a copper tube about 25 c.m. long with the sides 3 m.m. thick. The bulb of the thermometer is introduced into the tube, placed horizontally, where it is heated by conduction, and the temperature is regulated by placing the lamp under the tube at the requisite distance from the part containing the bulb of the thermometer. In this way it is easy to maintain a sufficiently constant temperature, because small movements of the main body of the mercury do not usually force the detached column to change its position.

The Value of the Degree.

The first accurate researches in thermometry were made in order to find suitable means of determining the two points which fix the value of the degree, and the necessary precautions for determining the freezing- and boiling-points are described in the physical text-books. It is important to use a good barometer, which does not require a notable correction for the capillary depression; and in order that the reduction of the mercury column to zero may be exact, the barometer should be sheltered from rapid changes of temperature. This may be conveniently effected as recommended by Professor Rowland, by wrapping the barometer with its thermometer in several folds of flannel. Instead of the boiling apparatus of Regnault, a glass flask with a long neck of at least 6 c.m. diameter may be substituted without diminishing notably the accuracy of the determination. In all cases the bulb and the entire mercury column must be heated in the steam.

The thermometer may be inserted through a pin-hole pricked in a thin diaphragm of rubber, so that only a few tenths of a degree need be withdrawn from the steam in order to make an observation. Zinc or copper turnings are put in the water.

It is very important to follow an invariable order in observing the points 100° and zero. The 100° point is

observed first, and it is indispensable to make the zero determination immediately afterwards. Instead of allowing the thermometer to cool in the vessel used for the boiling-point of determination, it should be taken out quickly, while heated to 100° , and as soon as it has taken nearly the temperature of the air (this requires five to seven minutes), it is plunged into snow which has been for a long time in contact with distilled water. When snow cannot be procured, it is best to substitute ice finely divided by planing it with an ordinary wood plane. This artificial snow may be placed in a cavity at least 5 c.m. in diameter, made in a mass of pounded ice, filling a large vessel, which should be provided with means for draining off the water.*

Even with the best thermometers it is not common to find that exactly 100° of the scale are comprised between the temperature of steam at 760 m.m. pressure (barometer reduced to zero) and the temperature of melting ice. The standard thermometers show divergences of several hundredths of a degree, and thermometers which are made for use in chemical laboratories have errors which are sometimes as high as zero, 0.8° in 100° , which would entail an error of 2.4° at 300° , since all the measures of temperature are divided by the value of the degrees established between 100° and zero.

It is necessary always to follow the method indicated, or at least an invariable matter in determining the value of an interval 100° to zero, since a variation of method may cause this quantity to vary 0.2° to 0.5° .†

Even when an invariable method is employed for the observations, important errors may proceed from another cause, which has hitherto escaped attention: the value of the degree itself usually varies each time that a change of position of the zero-point occurs, and all the constants of the thermometer are changed in different proportions.

During the ordinary usage of a new thermometer at temperatures above 100° a gradual elevation of the zero-point takes place, and the value of the degree changes at the same time. This movement has been followed with seven thermometers made at Paris, of crystal glass containing about 18 per cent of oxide of lead; and during a series of experiments like those common in chemical laboratories, the following elevations of the zero-point and augmentations of the interval 100° to zero were observed simultaneously. The movement was progressive during the whole series of experiments, but only the final variations are given in the table.

* In all exact determinations the snow should cover a considerable part of the scale, and instead of uncovering the zero at the moment of reading its position, it is preferable to bring this point before the smaller aperture of a conical glass tube, which is embedded in the snow, so that the divisions of the thermometer can be read by looking into the larger end. With this arrangement the scale can be conveniently observed with a telescope furnished with a micrometric eyepiece, the lighting is good, and the air of the tube being cooled to zero, the observation is not hindered by the moisture which is usually condensed on the stem of the thermometer in the ordinary method of making zero-point determinations.

† The method here recommended has always been followed by certain experimentalists, and M. Baudin has employed for a long time a similar process for the graduation of his thermometers, but it is only lately that the rule can be considered as established among physicists to take as a point of departure of each measure of temperature the position of the zero-point determined immediately after each observation. The best arguments in favour of this mode of proceeding have been given in the excellent memoir of Dr. Pernet, who has shown what confusion arises when the zero-point is observed before the determination of temperature. In this last case it is necessary to take into consideration the changes which preceding operations have caused in the position of the zero-point, and a minute study of the special qualities of the thermometer is required before the measures taken by different methods can be compared with each other. Dr. Pernet has calculated a series of corrections of this kind for temperature between zero and 100° , and the data will be given further on for making similar calculation in the case of higher temperatures, but only when the zero-point at its maximum of elevation is to be dealt with. The observations of several authors lose all value as true measures of temperature from the absence of details regarding the method which they have employed. It is to be noticed that the graduation of instruments at the Kew Observatory is still based upon the determination of the zero before that of the higher temperature.

Nos. of thermometers—

	45	46	47	50	52	53	54
Rise of the zero-point—	2'11	1'24	1'36	2'76	2'38	3'39	2'40°
Increase of the interval 100° to 0°—	0'14	0'06	0'05	0'13	0'10	0'19	0'07°

By inducing larger elevations of the zero-point the corresponding changes in the interval 100° to zero can be better studied, because certain irregularities are then only of slight relative importance compared with the larger numbers which have to be considered.

The following series of experiments is well fitted to show the magnitude of these changes, and they were also undertaken particularly to test the point whether the changes produced at moderately high temperature were similar in character to those observed after heating to the highest temperatures to which the thermometer can be conveniently exposed.*

Nos. of thermometers	1	2	3	4	5
Rise of the zero-point	23'0	24'0	26'0	16'6	11'0°
Increase of the interval 100° to 0°—	0'9	0'45	0'85	0'50	0'70

Nos. of thermometers	6	7	11	13	15
Rise of the zero-point	15'8	11'7	9'9	12'0	13'7°
Increase of the interval 100° to 0°—	0'80	0'50	0'94	0'77	1'30

The thermometers No. 1, 2, 3, 4, 11, 13, and 15 were made of French crystal glass containing about 18 per cent of oxide of lead. The Nos. 5, 6, and 7 were of German soda glass. The seven thermometers were heated eleven days at 355°. The Nos. 11, 13, 15 were heated three years at 166°, 206°, and 266°. It will be seen that similar effects are produced at these relatively lower temperatures and at the highest, and no known fact justifies the opinion of several authors that the phenomena which take place when glass is heated change their character at the different temperatures within the above range. Even at 100° by prolonged heating an augmentation equal to about 0'05° of the interval 100° to zero may be produced, while the position of the zero-point is raised by some tenths of a degree.

Thus after any change in the position of the zero the interval of 100° to zero must be determined anew, and usually a new value for the degree will be found by which all the measures of temperature must be divided. But measures thus corrected will probably not stand in a simple relation with the old ones, and after each considerable change of the position of the zero-point the thermometer should be again compared with the air thermometer throughout the whole length of its scale in order to establish a new series of corrections.

It will be thus seen that this phenomenon has a most disastrous influence upon the precision of thermometric measurements, and it is important to examine into the causes of these movements and to endeavour to find means to suppress them.

Depression of the Zero-point.

Let us consider the case of a thermometer which has been brought by special treatment to what may be called its normal condition at the ordinary temperature. This

* Dr. Pernet (*Comptes Rendus*, xci., 471) had stated his opinion that no variation of the interval of 100° to zero is produced when the heating takes place at temperatures not higher than 100°. According to my experiments a variation of the interval must always be looked for when the position of the zero-point changes, and under certain conditions a constant relation may be observed between the amplitudes of these two movements. I have given (*Ibid.*, p. 574) an hypothesis which may serve as a guide to the study of this phenomenon, but I do not propose here to discuss theoretical views, nor to enter into the details of certain experiments which were suggested by them. In this paper it is intended only to discuss the side of the question which is practically more important: namely, the possibility of obviating this source of error. The means by which this result may be effected will be described in full. They consist in a preparatory treatment of the thermometer which serves to make the position of the zero stable within certain narrow limits, and at the same time the value of the degree becomes practically unalterable.

is effected by causing the disappearance of certain persistent and abnormal expansion of the glass by heating a very long time (several days at 355°) and by cooling very slowly (during several weeks). When such a thermometer is heated successively at a series of different temperatures, each higher than the last, and after each heating cooled immediately in the air and the zero-point observed, a depression of zero is found to correspond with each successive heating at the increasing stages of temperature, and the extent of the depressions rises in a more rapid ratio than the temperatures of the heatings to which they correspond.

It is a well-known fact that the extent of the depression depends upon the manner in which the thermometer is cooled to the ordinary temperature; for example, after heating to 100°, if the thermometer, instead of cooling directly in the air for five to seven minutes, is taken from the heating apparatus and plunged immediately into a series of baths regulated at 60°, 30°, &c., it can be brought to the temperature of melting ice in one or two minutes, and in this case the position of the zero is about 0'05° lower than in the first case. This process of rapid cooling by means of baths is employed by M. Baudin, and consequently the interval of 100° to zero on his thermometers is greater by 0'05° than it is found when determined by the method recommended in this paper.

If the thermometer is cooled as slowly as possible during twenty-four hours after having been heated to 100°, the position of the zero is about 0'15° higher than when it is cooled in the air, and the position of the zero-point is raised about 0'15° still higher when the thermometer is cooled slowly and methodically during a period of several weeks. It is evident that each way of operating would give a different value for the degree.

The method which has been recommended above gives values for the interval 100° to zero which are constant to about one-hundredth of a degree.

The first vertical column of the table contains the numbers designating six thermometers, of which No. 5 is made of soda glass, the others are of crystal containing about 18 per cent of oxide of lead. The remaining columns give the depressions corresponding with the temperatures to which the thermometers have been heated.

It is to be noted that the time required to produce a maximum depression varies with the temperature. At 60° it requires several days, at 100° a few hours, and at the highest temperature from ten to fifteen minutes. The position of the zero at the maximum of depression remains constant on successive heatings at the same temperature.

Table of Zero-point Depressions.

Temperatures	40	60	80	100	160°
No. 1	0'00	0'06	0'19	0'31	0'74°
5	0'04	0'08	0'18	0'29	0'56
13	0'02	0'03	0'17	0'31	0'69
15	0'01	0'05	0'18	0'31	0'75
31	0'02	0'06	0'22	0'37	0'84
32	—	—	—	0'28	0'69

Temperatures	218	260	306	355°
No. 1	1'12	1'33	1'63	2'19°
5	0'76	0'91	1'14	1'51
13	0'87	1'09	1'30	2'15
15	0'97	1'12	1'40	2'05
31	1'15	1'46	1'77	—
32	0'98	1'21	1'56	2'06

This table may be used in the following manner to compare observations made by different methods. Suppose, for instance, that a temperature has been measured by the method which was chiefly used formerly, the zero-point was first taken, and then a series of rising temperatures was observed, as, for example, 100°, 200°, and 300°. The same observations referred to a zero-point determined immediately after each one will give the measures 100'3°, 201'0°, and 301'5°, if the depressions had been the

same as the thermometer No. 1 in the table. All these last observations are to be divided by 1.003, which is the value of the degree in this case, and thus the second method would give 100°, 200.4°, and 300.6°, instead of 100°, 200°, and 300°. The table of corrections to reduce the scale of mercury thermometers to that of a gas thermometer is founded on the assumption that the last method of observation has been employed; and consequently when any other method is used, additional corrections like those above must be applied, and the rate of the zero-point depressions under the circumstances of the experiments must be known.

The preceding calculations are only applicable to the cases in which the zero-point has completely returned to its normal position at the commencement of a series of experiments, and also the successive heatings must take place at increasing temperatures. Very often the depression of the zero produced by the preceding experiments still persists at the commencement of a new series, and in that case, instead of observing a depression on heating, a rise of the zero-point is to be noticed, and a knowledge of the laws regulating the elevation of the zero is required to calculate its position in such an experiment. It will be seen that the relations between the measures made by different systems may become extremely complicated, and it is to avoid difficulties of this nature that an invariable method has been recommended, viz., that which takes for the point of departure of each measure the position of the zero determined immediately after each observation of temperature.

(To be continued.)

A RECALCULATION OF THE ATOMIC WEIGHTS.*

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GLUCINUM.

THE atomic weight of glucinum is at present much in doubt; our knowledge of it depending upon the unsettled question whether the oxide is GfO or Gf_2O_3 . The formula GfO agrees with Mendelejeff's law, and is advocated by Reynolds,† Lothar Meyer,‡ and Brauner.¶ The symbol Gf_2O_3 , on the other hand, is favoured by Nilson and Pettersson,§ and by Humpidge.¶ Humpidge, Meyer, and Brauner offer only theoretical discussions of the subject; Reynolds and Nilson and Pettersson have determined the specific heat of the metal, but give opposed results. In the following calculations the simpler formula will be assumed, not as a finality, but because of its accordance with the system of Mendelejeff.

The data from which we are to calculate the atomic weight of glucinum have been determined by Awdejew, Weeren, Klatzo, Debray, and Nilson and Pettersson. Berzelius's** single experiment on the sulphate may be left out of account.

Awdejew,†† whose determination was the earliest of any value, analysed the sulphate. The sulphuric acid was thrown down as barium sulphate; and in the filtrate, from which the excess of barium had been first removed, the glucina was precipitated by ammonia. The figures which Awdejew publishes represent the ratio between SO_3 and GfO , but not absolute weights. As, however, his

calculations were made with $\text{SO}_3 = 501.165$, and Ba probably = 855.29, we may add a third column showing how much BaSO_4 is proportional to 100 parts of GfO :—

SO_3 .	GfO .	Ratio.
4457	1406	921.242
4531	1420	927.304
7816	2480	915.903
12880	4065	920.814

Mean 921.316 \pm 1.577

The same method was followed by Weeren and by Klatzo, except that Weeren used ammonium sulphide instead of ammonia for the precipitation of the glucina. Weeren* gives the following weights of GfO and BaSO_4 . The ratio is given in a third column, just as with the figures by Awdejew :—

GfO .	BaSO_4 .	Ratio.
0.3163 grm.	2.9332 grm.	927.031
0.2872 "	2.6377 "	918.419
0.2954 "	2.7342 "	925.592
0.5284 "	4.8823 "	902.946

Mean 918.497 \pm 3.624

Klatzo's† figures are as follows, with the third column added by the writer :—

GfO .	BaSO_4 .	Ratio.
0.2339 grm.	2.1520 grm.	920.052
0.1910 "	1.7556 "	919.162
0.2673 "	2.4872 "	930.490
0.3585 "	3.3115 "	923.710
0.2800 "	2.5842 "	922.989

Mean 923.281 \pm 1.346

Combining these series into a general mean, we get the subjoined result :—

Awdejew	921.316 \pm 1.577
Weeren	918.497 3.624
Klatzo	923.281 1.346

General mean .. 922.164 0.935

Hence $\text{GfO} = 25.224 \pm 0.269$.

Debray‡ analysed a double oxalate of glucinum and ammonium, $\text{Gf}(\text{NH}_4)_2\text{C}_4\text{O}_8$. In this the glucina was estimated by calcination, after first converting the salt into nitrate. The following percentages were found :—

11.5
11.2
11.6

Mean 11.433 \pm 0.081

The carbon was estimated by an organic combustion. I give the weights, and put in a third column the percentages of CO_2 thus obtained :—

Salt.	CO_2 .	Per cent CO_2 .
0.600 grm.	0.477 grm.	79.500
0.603 "	0.478 "	79.270
0.600 "	0.477 "	79.500

Mean 79.423 \pm 0.052

Calculating the ratio between CO_2 and GfO , we have for the molecular weight of the latter, $\text{GfO} = 25.220 \pm 0.180$. The agreement between this result and the one previously deduced from the sulphate is certainly very striking.

Last of all and best of all we come to the determinations recently published by Nilson and Pettersson.¶ These

* Smithsonian Miscellaneous Collections. "The Constants of Nature."

† *Phil. Mag.*, (5), 3, 38. 1877. *CHEMICAL NEWS*, xlvii., 273. 18806.

‡ *Ber. der Deutsch. Chem. Gessel.*, 13, 1780. 1880. Also, 11, 57 1879.

¶ *Phil. Mag.*, (5), 11, Jan., 1881.

§ *Berichte*, 11, 381 and 906. 1879. Also, 13, 2035. 1880.

¶ *CHEMICAL NEWS*, xlii., 261. 1880.

** *Poggend. Annal.*, 8, 1.

†† *Ibid.*, 56, 106. 1842.

* *Pogg. Annal.*, 92, 124. 1854.

† *Zeit. f. Anal. Chem.*, 8, 523. 1869.

‡ *Annales de Chim. et de Physique*, (3), 44, 37. 1855.

¶ *Comptes Rendus*, 91, 168. 1880.

chemists sought to use the sublimed chloride of glucinum, but found it to contain traces of lime derived from a glass tube. They finally resorted to the sulphate as the most available salt for their purposes. This, which they write $\text{Gl}_2(\text{SO}_4)_3 \cdot 12\text{H}_2\text{O}$, and which we formulate as $\text{GlSO}_4 \cdot 4\text{H}_2\text{O}$, yields pure glucina upon strong ignition. The subjoined percentages of glucina were thus obtained:—

14.171
14.169
14.160
14.176

Mean 14.169 \pm 0.0023

Hence $\text{GlO} = 25.048$, and $\text{Gl} = 9.085 \pm 0.0055$. If $\text{O} = 16$, $\text{Gl} = 9.106$. If $\text{SO}_3 = 80$, then $\text{Gl} = 9.096$.

If the oxide is Gl_2O_3 , then the value $\text{Gl} = 9.085 \pm 0.0055$ becomes $\text{Gl} = 13.628 \pm 0.0082$.

It would be easy enough to combine this value for Gl with those derived from the experiments of the investigators previously cited, but it is hardly worth while. All the other estimations have such high probable errors that they would practically vanish from the general mean. Their influence would hardly extend to the third decimal place, and they may therefore be neglected.

PROCEEDINGS OF SOCIETIES.

THE INSTITUTION OF CIVIL ENGINEERS.

THE second of the six lectures on "*Heat in its Mechanical Applications*" was delivered on Thursday evening, the 6th of December, by Mr. WILLIAM ANDERSON, M.Inst.C.E., the subject being "The Generation of Steam, and the Thermodynamic Problems Involved."

The Lecturer commenced by remarking that the source of our fuel supply was derived from the rays of the sun acting upon the earth ages ago. He pointed out that those rays were of complex structure, intimately bound together, and yet capable of being separated and analysed. He remarked that it required over 1000 H.P. to separate 1 ton of carbon from the atmosphere in twelve hours; but that, in consequence of the enormous area of leaf-surface in which the decomposition took place, the action was silent and imperceptible.

As soon as a law of definite chemical combination had been established, chemists began to suspect that the changes of temperature observed in chemical reactions were also of a definite kind, and that they were as much the property of matter as chemical atomic weights. In the last century Lavoisier and Laplace, and after them, down to the present time, Dulong, Despretz, Favre and Silbermann, Andrews, Berthelot, Thomsen, and others, had devoted much time and labour to the experimental determination of the heat of combustion and the laws which governed its development. Messrs. Favre and Silbermann, in particular, between the years 1845 and 1852, had carried out a splendid series of experiments, by means of a calorimeter, which was illustrated by a diagram. The apparatus consisted of a gilt copper receiver, in which the substances tested were burnt by a jet of gas. This receiver was immersed in another vessel containing water, which again was protected by another vessel lined with swans-down. Thermometers of great delicacy were employed to determine the temperatures, and the whole of the apparatus, used for generating the gases and for collecting the products of combustion, was constructed with the utmost ingenuity and skill. Messrs. Favre and Silbermann adopted the plan of ascertaining the weight of the substances consumed, by calculations from the weight of the products of combustion. By this means they were

enabled to deal with larger quantities, and several errors incidental to the opposite process were eliminated. A Table was given showing the calorific value and the chemical composition of such substances as commonly formed the constituents of fuel.

The thermo-chemical laws relating to combustion and decomposition were then stated, and the general formula for calculating the thermic value of any kind of fuel whose analysis was known was explained. It was pointed out that energy existed on the earth in a form which was often unsuitable for the wants of man:—for example, the water flowing down the Alps was competent to furnish the power necessary for boring through those mountains; but it was not in a form which could be used directly. The kinetic energy of the water had first to be transformed into the potential energy of compressed air, and in that form it became available for the miners.

In the same way, the energy of combustion could not be applied directly to the wants of man. It had first to be converted into the form of steam or air at high pressure and temperature, and then, by means of suitable heat-engines, it could be used in the manner with which all were familiar. It was probably to this circumstance that the tardy development of the steam-engine was due, for its history dated back only some two hundred years—a very small proportion of the time during which the human race had existed.

A steam boiler was in reality a species of heat-engine, and its action should be investigated upon the same principles, and consequently the doctrines of Carnot were applied. According to these, the efficiency of a boiler depended entirely upon the range of temperature through which the heated gases acted, and, by means of an illustration derived from an application of water power, it was demonstrated that the proper way to increase the efficiency of a boiler was to raise the temperature of the furnace to the utmost degree possible, and to lower the temperature of the smoke to the lowest point practicable. Particular instances were then taken in which it was shown that 1 lb. of carbon would be capable of evaporating 14.87 lbs. of water from and at 212°. The case of the prize engine of the Cardiff show of the Royal Agricultural Society in 1872 was described in detail, and it was demonstrated that the maximum amount of work which could be expected from its boiler was equivalent to the evaporation of 13.27 lbs. of water, the actual evaporation having been 11.83 lbs., showing a duty of 89 per cent. In pursuance of the idea of treating a boiler as a heat-engine, an indicator diagram was exhibited and explained, and the laws of Carnot were stated in detail and discussed. The terms of Carnot's formula were then examined separately—first, in relation to the temperature of the furnace, the process of combustion was explained, and it was shown that the temperature of the furnace depended upon the supply of air. A minimum supply would give the highest temperature, but it was found necessary to add an excess in order to make combustion perfect. It was pointed out that the limit to high temperature in a furnace was the imperfection of the material out of which boilers were constructed. It was shown from the fact that steel was capable of being melted in boiler furnaces, that temperatures so high as that were not injurious; but that, when that melting-point of steel was greatly exceeded, the boiler plates began to suffer severely. Next, the temperature of the chimney end of the boiler was examined. It was stated that by the adoption of feed-water heaters and by the use of forced draught, not for the purpose of augmenting the steam-production irrespective of economy, but with a view to promoting economy, that the temperature of the smoke could be lowered to about 100° above that of the feed-water. The loss of 11 per cent in the Cardiff boiler was then looked into, from which it appeared that it arose partly from radiation and convection from the body of the boiler, partly from imperfect combustion, which always prevailed more or less, and partly from losses incidental to the transfer of heat from substances

less dense to others more dense, and *vice versa*. It was stated that this loss was common to all energy propagated by undulatory motion, such as light, heat, or sound. The law of conduction through plates was then explained, and it was pointed out that even joints in a bar of uniform material interposed a certain amount of resistance, and the fact was illustrated by an experiment. The loss was much greater when there was a joint between dissimilar materials, such as between the gases of the furnace and the boiler plate, and between the boiler plate and the water. At first sight it would appear a matter of common sense that a boiler which contained its own furnace must be a better generator than one with an external furnace formed of brick-work; but brick-work was an extremely bad conductor of heat, while it was a very good radiator, absorbing heat from the gases and returning them by radiation to the boiler surfaces. This action was strongly pronounced in the case of the reverberatory furnace, and in the brick arches now commonly introduced into the fire-boxes of locomotives.

The gases forming the products of combustion were very bad absorbers, and very bad radiators of heat. Pure dry air and nitrogen were absolutely incapable of absorbing or radiating heat. They were not in the least affected by the passage through them of the most intense heat-rays. Carbonic acid was a somewhat better radiator, while the vapour of water was a good absorber, and therefore a good radiator. It was then demonstrated that the products of combustion consisted mainly of air and nitrogen, and consequently, taken as a whole, the products of combustion were bad radiators. Little or no economical advantage was derived from making the combustion in the boiler perfect, because the colder luminous flame was a good radiator, on account of the white-hot particles of carbon it contained, while the hotter and non-luminous flame was a bad radiator, and carried a great deal of the heat into the chimney. This circumstance was illustrated by an experiment, by which it was proved that an intensely hot non-luminous Bunsen flame had very little more effect upon an air thermometer than a smoky luminous flame burning the same quantity of gas, but that the moment a spiral wire was hung in the Bunsen flame, it commenced to glow, and the radiation from the wire immediately had a powerful effect upon the thermometer. It was probably owing to this circumstance that the backwardness of the owners of steam-boilers to prevent smoke was to be attributed. Had considerable advantage been obtained by the suppression of smoke, Acts of Parliament would not have been necessary for the purpose.

A different class of boiler was required for consuming flaming fuel, as contrasted with such fuel as anthracite and coke, burning with very little flame. In the latter case, tubular boilers were preferable; but unless the combustion was perfect before the gases reached the small tubes, the gases cooled down so considerably that the flame was frequently extinguished. This fact was illustrated by an experiment, which showed that when pieces of $\frac{1}{2}$ -inch gas-pipe of various lengths were placed over an ordinary gas-flame, the shorter tubes allowed the flame to pass through, while the longer ones extinguished it, and the gas could be re-lighted at their upper ends. Water, being completely adiabatic, and a very bad conductor, could not be heated by direct radiation or conduction. The process of heating by convection was explained in detail, and a comparison was instituted between the heat transmitted from the hot gases in the furnace of a boiler to the water, with the reverse effect of warming by the transfer of heat from hot water pipes to the air of a room. The two being reverse operations, agreed very closely together in accordance with the theory of exchanges. The proper heating-surface to be allowed in a boiler to effect a given amount of evaporation was then dwelt upon. The mode of calculating the sectional area of tubes and flues was given, the heat of the chimneys and their area was considered, and finally the thermodynamic theories relating to the formation of steam were investigated. It was stated that,

of necessity, the molecules of steam which became emanated from the water through the energy of heat, carried with them particles of water, and that these particles constituted priming, the amount of which depended upon the velocity with which the steam escaped from the water. A Table was exhibited of a large variety of boilers ranged in order of the velocity and disengagement of steam from the water-surface; and from this it appeared that those in which the velocity was highest were also those most subject to priming. The doctrine of the viscosity of liquids and gases was next dealt with, and applied to account for the manner in which particles of water and of very minute solid impurities were carried over from the water of the boiler into the steam. The same theory was adduced to show that from the slowness with which smoke fell in the atmosphere, it must be composed of exceedingly small particles, and that they were not very numerous compared with the volume of the gases with which they were associated. It further went to show how it was that complete combustion did not produce any marked economy, because the absence of the white-hot particles of carbon from the gases caused a loss of radiating power. It was thought that no great improvement was to be expected in the economy of boilers, for the limit had been already almost reached.

The honour of having first pointed out the true principles on which the duty of boilers should be estimated, namely, by comparing the work actually done with the potential energy of the fuel used, was due to the late Professor Rankine.

The Lecturer concluded by a tribute of respect and admiration to the late Sir William Siemens, whose name was closely associated with the subject of his lecture. At the time of his death, Sir William Siemens was engaged in perfecting a pyrometer, intended to indicate accurately temperatures above those of melting steel. In addition therefore to the many causes of regret for his lamented decease, was to be added this, that the production of a trustworthy pyrometer would be indefinitely postponed. The impulse which Sir William Siemens had given to the study and elucidation of thermodynamics would not cease with his life, but this and succeeding generations would long profit by his example and his labours.

CORRESPONDENCE.

ATOMICITY OF ELEMENTS AND COMPOUNDS.

To the Editor of the Chemical News.

SIR,—It seems to be a favourite hypothesis with chemists by way of accounting for water of crystallisation, the existence of hydrates, of double salts, of such compounds as Friedel's chlorhydrate of methyl oxide, the combination of phosphorus pentachloride with iodine chloride, of bromine and iodine with phosphorus pentachloride, and all such compounds, to suppose that there exists either in the atoms themselves composing the molecules some residue of unsatisfied atomicity, or that some of the elements themselves possess a variable atomicity. Thus platinum, which is usually quadrivalent in platonic salts, is supposed to become sexavalent in the double chloride of platinum and potassium; in other cases, chlorine to become bivalent, and bromine and iodine to change their atomicities. It seems difficult to suppose that monatomic bodies like these last, and bodies of which the valency seems so well determined, should be so liable to change their atomicity on frequent occasions. Is there any valid reason why we should not suppose that the entire molecules, acting as entities or compound atoms, come to possess an atomicity of their own, attracting one another, or the atoms of water as the case may be, or that water itself may possess an atomicity of its own?

If this be not the case it seems difficult to otherwise

account, among other things, for the great development of heat in many cases.

Dry calcium chloride, or zinc chloride, as well as many other salts, develop great heat in combining with water. So also does hydrated sulphuric acid.

Such strong combinations as these seem hardly accounted for by any residual atomicity of the elements composing the compounds, and some other reason is required.

I cannot possibly understand why recur to a hypothesis which upsets the whole atomic theory which we have so carefully and so laboriously built up while any other solution is open.—I am, &c.,

F. MAXWELL LYTE, F.C.S., F.I.C.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Moniteur Scientifique, Quesneville.
November, 1883.

Properties, Preparation, and Composition of the Nitrogen Iodides.—A. Guyard.—This voluminous paper is provided with several illustrations, and treats in the first place of the photometric properties of nitrogen iodide in the moist state or when under water.

Manufacture of Japanese Lacquer.—From the *Journal of the Society of Arts*.

Theoretic Researches on Alizarin-red Dyeing.—G. Saget.—The author has succeeded in obtaining calcium and aluminium alizarates, and proving their definite character. Both these salts are decomposed by dilute acids with liberation of alizarin. In pure water alizarin does not dye with aluminous mordants. Under a pressure of two atmospheres it forms a pale violet-red lake, but the alumina is not saturated. In order to effect dyeing, a salt of calcium must be present, preferably the carbonate. The first action of the alizarin is to form with the calcium carbonate, calcium alizarate, which undergoes double decomposition with the alumina fixed upon the cloth. Calcium carbonate is re-constituted and again enters into reaction. The lake is not a pure aluminium alizarate, but a double calcium aluminium alizarate. By dyeing, we obtain a garnet lake, which is not the true alizarin red lake, but is soiled by impurities from the wares employed and by an excess of calcium alizarate. It is purified by the clearing process, which consists of oiling, steaming, and soaping.

New Experiments on the Determination and the Physiological Production of Urea.—L. Hugounenq.—The author does not give his analytical process. He finds that in the normal condition, and under a normal nutrition, the ureic coefficient varies within certain limits directly as the quantity of nitrogen ingested. In a state of physiological inanition the figure of ureic excretion does not fall below 5 grms. of nitrogen. This minimum number may be called the coefficient of auto-combustion, and expresses the quantity of excrementitious nitrogen derived from the combustion of the organic tissues alone.

A New Method of Determining Nitrogen in Organic Matter.—J. Kjeldahl.—Already inserted.

Influence of Silica on the Determination of Phosphoric Acid by Means of Molybdic Acid.—A. Bertrand.—The author maintains that the previous elimination of silica is unnecessary. He differs also from Bolley and Kopp, who state that nitric acid does not completely dissolve mineral phosphates. He finds that nitric and hydrochloric acids are equally good solvents.

Oil of Winter-green as an Antiseptic.—This oil, methyl salicylate, is obtained by the distillation of *Gaultheria procumbens*. It is here pronounced more efficacious than phenol, though it has the disadvantage of being more costly.

Journal de Pharmacie et de Chemie.
Tome viii., November, 1883.

Experimental Study on the Microbicidal Action of Copper Sulphate.—M. Rochefontaine.—The spores of the mucedinæ can develop in solutions of copper sulphate containing 1 per cent. The vibriones of putrefaction swarm in cupric solutions at 1-10th per cent. The proportion of copper necessary to arrest the development of vibriones is at least four times greater than that which proves fatal to guinea-pigs, and ten times greater than that sufficient to destroy dogs. Experimental bacteriæmia can be equally produced in animals whether they have undergone subcutaneous injections of copper sulphate or not. Bacteria can be developed in the blood of animals which have died from the effects of copper sulphate, whether taken internally or introduced subcutaneously.

Influence of Salts of Lead on the Detection of Phosphorus by the Method of Mitscherlich.—H. Beckurts.—In Otto's treatise on poisons it is stated, on the authority of Schwanert, that the presence of lead salts hinders phosphorescence in Mitscherlich's apparatus. Researches undertaken with bread, meat, &c., mixed with the ends of phosphorus matches and various salts of lead, prove that these salts are no obstacle to the luminosity of phosphorus, and that phosphorous acid is easily detected in the apparatus.

Archives Neerlandaises des Sciences Exactes et Naturelles,
Tome xviii., Part 3.

The Equations of Motion of the Electro-magnetic Field.—C. H. C. Grinwis.—A mathematical paper, for which we must refer to the original.

Rhizopogonic Acid.—A. C. Oudemans, Jr.—This acid was first obtained by M. F. A. Hartsen from *Rhizopogon rubescens*, a fungus found in the South of France, and has been more closely examined by the author. Its formula seems to be $C_{20}H_{26}O_3$. In water it is completely insoluble. Ether, chloroform, carbon disulphide and ligroine dissolve it easily. It forms long, splendid crystalline needles of a blood-red whilst moist, but taking a more orange tint when dry, somewhat like sublimed alizarin, but without the same lustre. At 127° it melts to a brownish-red liquid and is decomposed at temperatures above 300° . It is a feeble acid, and decomposes the alkaline carbonates, but the salts formed are unstable, being decomposed if boiled with excess of water or alcohol.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome x., October, 1883.

Report presented by M. Aimé Girard on M. Paul Horsin Déon's Treatise on the Manufacture of Sugar.—Not capable of useful abstraction.

Justus Liebig's Annalen der Chemie,
Vol. 221, Part 3.

Molecular Volumes of Liquid Substances.—R. Schiff.—The author gives the following as the more important results of this voluminous paper:—The specific volumes of carbon and oxygen are variable, varying with the variation of the atomic catenation. The presence of a so-called double bond increases the molecular volume. For each of these bonds between carbon and carbon the increment amounts to 4 unities. The benzol nucleus can contain no double, but merely single bonds.

MISCELLANEOUS.

Royal Institution of Great Britain.—Probable arrangements for the Friday Evening Meetings before Easter, 1884, to which Members and their friends only are admitted :—

- Jan. 18.—Prof. Tyndall, D.C.L., F.R.S., "Rainbows."
Jan. 25.—The Rev. Prof. T. G. Bonney, M.A., F.R.S., "The Building of the Alps."
Feb. 1.—Prof. F. Max Müller, "Râjah Râmmohun Roy, the Religious Reformer of India (died at Bristol, 1883)."
Feb. 8.—George J. Romanes, M.A., LL.D., F.R.S., "The Darwinian Theory of Instinct."
Feb. 15.—Prof. T. E. Thorpe, F.R.S., "The Chemical Work of Wöhler."
Feb. 22.—Sir Frederick Bramwell, F.R.S., "London (below bridge) North and South Communication."
Feb. 29.—Prof. D. E. Hughes, F.R.S., "Theory of Magnetism," illustrated by Experiments.
March 7.—C. Vernon Boys, A.R.S.M.
March 14.—J. N. Langley, F.R.S.—The Physiological Aspect of Mesmerism."
March 21.—Mr. Walter Besant, "The Art of Fiction."
March 28.—Prof. Osborne Reynolds, M.A., F.R.S., "The Two Manners of Motion of Water shown by Experiments."
April 4.

MEETINGS FOR THE WEEK

- THURSDAY, 27th.—London Institution, 7.
Royal Institution, 3 p.m. "Alchemy," by Prof. Dewar.
FRIDAY, 28th.—Quekett, 8.
SATURDAY, 29th.—Royal Institution, 3. "Alchemy," by Prof. Dewar.

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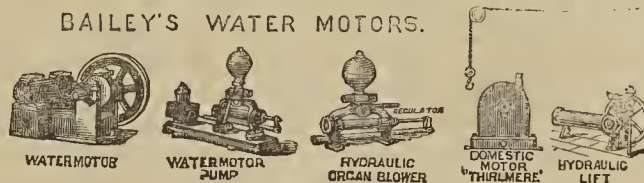
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THE CHEMICAL NEWS.

VOL. XLVIII. No. 1257.

REDUCTION OF METALLIC SOLUTIONS BY
MEANS OF GASES, &c.*

By Dr. G. GORE, F.R.S.

THE following experiments were made chiefly for the purpose of ascertaining the effect of various gases and liquids in reducing metals from their solutions.

Experiment 1. A mixture of dry and pure carbonic oxide and carbonic anhydride gases, passed in a stream slowly through various liquids, had the following effects:—A solution of bichloride of palladium was rapidly decolourised, and all its metal precipitated as a black powder. One of tetrachloride of platinum was slowly decomposed, and yielded a small amount of yellow precipitate in two or three days. With one of chloride of iridium and potassium, the whole of the iridium was precipitated after a long time. Solutions of argentic nitrate, mercuric chloride, plumbic nitrate, ferric chloride, manganous chloride, permanganate of potassium, chromic acid, and a green solution of vanadium, showed no signs of reduction. A solution of green vitriol with which an excess of pure sodic hydrate had been mixed did not become oxidised.

2. The same mixture of gases was passed through a lead vessel containing milk of lime. It imparted to the surface of the vessel a film of red oxide of lead, probably by reduction of carbonate of lead by the carbonic oxide.

3. By passing carbonic oxide during two days through a solution of potassic cyanide with a rod of bright magnesium half immersed in it, the liquid became brown, and the metal was coated with a blackish film in the liquid. Magnesium alone in a similar solution did not turn the liquid brown in three days.

4. A dilute solution of bichloride of palladium exposed to a mixture of hydrogen and carbonic anhydride (or to pure hydrogen alone), had the whole of its palladium gradually precipitated in the metallic state in a period of twenty-four hours.

5. An atmosphere of coal-gas was maintained in contact with the following dilute liquids, each of which had a vertical platinum wire partly immersed in it. The liquids were in open bottles in a dark place. Dilute solution of palladic chloride:—Rapid reduction to the state of metal as a film upon the surface of the liquid in four hours; the solution became colourless in a few days; some of the metal was also precipitated as a black powder, and some as an adhering bulky lump on the end of the wire. With dilute terchloride of gold, in the course of a few days, beautiful films of metal, bright, and of exceeding thinness, were produced upon the surface of the solution. Much gold was also deposited upon the bottom end of the wire. The films formed successively and sank. The liquid was not wholly decomposed in three weeks. Solid crystals of auric-chloride were gradually reduced to metal. Solution of platonic chloride was only slightly decomposed in ten weeks. With a solution of argentic nitrate:—Signs of decomposition occurred in a few hours. In fourteen days a deposit of metal had formed upon the sides of the glass bottle; but the whole of the silver was not deposited in seven weeks. With cupric sulphate, no reduction, and but little action upon a strip of copper (instead of platinum) took place in ten weeks. With a platinum wire in a dilute solution of ferric sulphate, no visible effect occurred in eighteen days.

6. The gaseous products (containing acetylene) of a blown down and smoky flame of a Bunsen burner were collected over water and passed through various liquids. They rapidly decomposed a solution of palladic chloride, and less quickly one of terchloride of gold; a solution of platonic chloride was slightly affected, and one of chloride of iridium and potassium remained unaltered.

7. A solution of palladic chloride in contact with amylene showed signs of decomposition even in a few minutes, and was abundantly decomposed in two days; it was also reduced to metal by American petroleum, benzine, and Persian naphtha less speedily; slowly by toluol, xylol, "petroleum ether," and mesitylene; with the ether, a bright metallic layer was formed between the two liquids. It was reduced very slowly by Rangoon lamp-oil, and by "sherwoodole," and not at all by ozokerite, solid paraffin, or naphthalene.

8. An aqueous solution of auric chloride, especially a strong one, was rapidly decomposed by carbolic acid, with liberation of the metal; also, but more slowly, by mineral naphtha, Persian rock-oil, benzole, C_2Cl_2 , and Rangoon machinery oil, with similar effects; slowly by "petroleum ether," and very slowly by toluol, xylol, and mesitylene; paraffin, anthracene, naphthalene, C_2Cl_4 , Rangoon petroleum butter, C_2Cl_6 , benzoic acid, soft elaterite, hard elaterite, CCl_4 . Sherwoodole, chrysene, or ozokerite had but little or no decomposing effect. The solution of chloride of gold was less rapidly decomposed than one of palladic chloride, especially by mineral naphtha and benzole. Amylene produced a most beautiful film of gold upon the surface of the auric solution.

9. Platinum was separated from a solution of platonic chloride by benzole, American rock-oil, Persian naphtha, and other similar liquids.

10. An aqueous solution of chloride of iridium and potassium was decolourised in two days by contact with benzole. With amylene no effect was visible in that time.

11. Amylene, in contact with an aqueous solution of mercuric chloride during one week, slowly produced a white precipitate. By agitating amylene with a solution of permanganate of potassium, the latter was instantly decolourised; the residue was entirely soluble in hydrochloric acid, but with one of cupric chloride in aqueous ammonia, or of ferric chloride, chromic acid, chromate, or acid chromate of potassium, no visible effect occurred.

12. Benzole, agitated with a solution of potassic permanganate, rapidly decolourised it, but had no effect upon one of perchloride of iron. Benzole darkened the colour of solutions of palladium, gold, and platinum.

13. With a solution of telluric chloride, or one of terchloride of antimony, amylene, benzole, and Persian naphtha produced only a slight effect in fourteen days. With Persian naphtha and a solution of chloride of bismuth, a slight change occurred in eleven days.

The films of gold and palladium formed upon the surface of a liquid by contact of a gas, or between two liquids at their dividing line by a non-miscible solution, might prove of service in some physical experiments.

It is worthy of consideration whether the reduction of metals to the native state in the interior of the earth may not in some cases have been effected by contact of their solutions with liquid or gaseous hydrocarbons derived from coal and other mineral substances of organic origin.

Reactions of the Aromatic Chloro-carbons.—A. Weber and C. Söller. The aromatic chloro-carbons, especially perchlorised benzol and diphenyl, are by no means so indifferent in alcoholic solutions of alkalies as is commonly supposed. Perchlor-diphenyl, if kept for some hours at 180° to 200° in alcoholic soda, yields products which are readily soluble in alkalies and are re-precipitated by acids as white, caseous flocks.—*Berichte der Deutschen Chemischen Gesellschaft zu Berlin.*

* Read before the Birmingham Philosophical Society, December 13th, 1883.

THE QUALITATIVE AND QUANTITATIVE
SEPARATION OF BISMUTH AND COPPER.

By Dr. JULIUS LÖWE.

SOME time ago the author communicated to this journal the observation that the oxides of bismuth and copper in solution are precipitated by soda or potassa in presence of glycerin, but are completely re-dissolved by an excess of the precipitant. In this alkaline solution both show a similar behaviour with a solution of glucose, being both reduced at a boiling heat, the copper to red cuprous oxide and the bismuth to grey, finely-divided metal. They differ, however, in their behaviour with glucose, in the cold or at a gentle heat; copper in the course of several hours being completely deposited in the form of red cuprous oxide, whilst the alkaline solution of bismuth undergoes no change. Not until after the solution has stood for some days are small quantities of the bismuth deposited in the metallic state. This reaction may be very conveniently used for separating copper and bismuth as well quantitatively as qualitatively from a mixed solution in nitric acid, in all cases when the bismuth predominates.

For this purpose the nitric solution, not too acid and not too concentrated, is placed in a beaker and mixed with a measured volume of soda-lye until the oxides are precipitated and the supernatant liquid shows an alkaline reaction. During this process the temperature must not be allowed to rise. Then double the volume of the lye consumed is added, and pure, syrupy glycerin is then stirred in until the oxides are completely re-dissolved and the liquid becomes clear. This deep blue solution is mixed with a solution of pure glucose (1 part in 6 to 8 parts of water) in such a proportion that the sugar may amount to three to four times the joint weight of the metals. The beaker is then covered with a well-fitting glass plate, and the liquid is let stand 8 to 10 hours in a cool, dark place. The blue colour is then found to have given place to a deep yellow, whilst the copper is deposited at the bottom of the beaker as a bright red oxide, mostly not adhering to the glass. The yellow liquid is poured off, without stirring, upon a filter which has been dried at 100° and weighed. The cuprous oxide is washed by decantation, first with water, containing a little glycerin, and soda-lye, collected upon the filter, and then well washed with distilled water. After the last portions of washing-water, which should be free from alkaline reaction, are run off, the filter is cautiously lifted out of the funnel, laid upon good absorbent paper, and then dried at 100° in the air-bath. The increase of weight of the filter gives the quantity of red oxide, 100 parts of which represent 88.8 parts of metallic copper.

Where greater accuracy is required the red oxide obtained after weighing is converted into oxide in the ordinary manner after incineration of the filter, &c., and the copper is determined in its solution by any ordinary method.

The alkaline filtrate, containing all the bismuth, is placed in a sound, well-glazed porcelain capsule, heated to a boil over a free flame, stirring gently, kept at this temperature for a short time, removed from the source of heat, and the brownish liquid is allowed to cool and settle. It is then filtered through a filter which has been dried at 100° and weighed. The metallic bismuth is first washed by decantation with water containing soda, collected on the filter, and further washed first with cold and then with hot water. The drying is effected as in the case of the cuprous oxide, and the increase of weight of the filter gives the quantity of the bismuth.

The glaze of the porcelain capsule must be of the best quality, lest any particles of metal may be deposited upon it and prove hard to remove. The metal is also reduced in the water-bath, but less rapidly than over the naked flame.

The finely divided metallic bismuth must be washed

and dried as rapidly as possible, so as not to remain too long in contact. The filter must be of the best paper, as the fine metallic particles may otherwise easily pass through.

If the weight of the bismuth is decidedly greater than that of the copper this process yields very satisfactory results. The author purposes to make further investigations on the converse case.—*Zeitschrift Analyt. Chemie.*

DETECTION OF CHLORINE, BROMINE, AND
IODINE.

By FRANCIS JONES, F.R.S.E.

IN the December number of the *Journal of the Chemical Society* some experiments are described on a process due to Vortmann, for the detection of chlorine, bromine, and iodine in mixtures. I have lately introduced a method (suggested to me by the process employed on the large scale for the manufacture of iodine and bromine) which is based on the same principle, but carried out in a simpler and more convenient manner, and which serves extremely well for the detection of the three elements. The process is carried on in the following way:—Place a small quantity of the mixture to be tested in a good sized test-tube, add a few pieces of manganese dioxide and then a little water. Add now one drop only of dilute sulphuric acid (one part acid to ten of water); a brown tinge indicates the presence of iodine. Boil the mixture, and confirm the presence of iodine by the violet vapours in the upper part of the tube. Continue the boiling till these vapours cease to appear, then add another drop of sulphuric acid and boil again till they cease. If necessary repeat this addition of acid and boiling until violet vapours have entirely ceased. Now add about two cubic centimetres of the dilute acid and boil again: brown vapours indicate bromine. Continue the boiling until the vapours no longer smell of bromine, then add one cubic centimetre dilute acid and boil again. When the vapours no longer smell of bromine allow the residue to cool *completely*; add an equal bulk of strong sulphuric acid and warm; a green gas bleaching a piece of moist red blotting-paper at the mouth of the tube indicates chlorine.

Occasionally some bromine comes off on addition of the strong acid, but if so it is soon got rid of, and is succeeded by the chlorine, which is chiefly evolved on warming the mixture. As, moreover, moist red blotting-paper is far more quickly acted on by chlorine than by bromine, there can be no difficulty in distinguishing between the two elements.

I have compared the results obtained by my students when using this and other methods, and find they are far more successful with the new method.

SEPARATION OF STRONTIUM AND CALCIUM.

By M. D. SIDERSKY.

THE method of separating these two metals is based on the following reaction:—When a mixture of oxalate and sulphate of ammonium is added to a salt of strontium containing calcium, the precipitate contains all the strontium in the form of sulphate, whilst the whole of the calcium is found in the form of oxalate. These two salts are then easily separated by dilute hydrochloric acid. By previously adding a little hydrochloric acid to the solution the precipitation of oxalate of calcium is prevented.

The method of working is as follows:—Suppose a strontianite is to be analysed. The powdered mineral is attacked at the boiling-point by the smallest possible quantity of strong hydrochloric acid, and the solution

supersaturated with ammonia, which precipitates iron, alumina, and silica. After filtration the liquid is concentrated by evaporation, acidulated with hydrochloric acid, and precipitated by a solution containing, per litre, 200 grms. of sulphate and 30 grms. of oxalate of ammonium. This precipitates sulphate of strontium, which is collected on a filter and weighed after washing. The filtrate, supersaturated with ammonia, yields a precipitate of oxalate of calcium.

The analytical results which the author quotes in support of this method are satisfactory.—*Zeitschrift für Analytische Chemie*.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING NOVEMBER 30TH, 1883.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the Water Examiner, Metropolis Water Act, 1871.

London, December 6th, 1883.

SIR,—We submit herewith the results of our analyses of the 182 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from November 1st to November 30th inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and the Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples submitted to analysis.

Of these 182 samples of water, the whole, with the exception of three samples which were recorded as "very slightly turbid," were clear, bright, and well filtered.

The supply throughout the month has continued to be of excellent quality; and in particular, the proportions of organic carbon, and consequently of organic matter, though in excess of the very small amounts recorded for several months past, have been low for the season of the year.

It will be observed that despite important differences of interpretation, the actual results obtained by ourselves are usually in fair accordance with those reported to the Registrar-General. Thus the mean amount of organic carbon in 100,000 parts of the water furnished during the six months preceding October, by the five Companies taking their supply exclusively from the Thames was, according to our experiments, 0.116 part, and according to the reports made by the Registrar-General, 0.123 part, a difference of 0.007 part only. As regards, however, the discrepancy noticeable in the two sets of results for October, we would call attention to the circumstance that our report was based on an examination of nineteen specimens of Thames-derived water, each collected on a different day; and that our determinations of organic matter by means of the combustion process were checked by the results of a wholly different process of examination. On the other hand, the report made to the Registrar-General on the character of the Thames "waters supplied to the

Metropolis during the month of October," was based on an examination of five specimens only, all collected on the same one day of the month. Further, the results, furnished by the combustion process applied to these five specimens, were wholly unchecked by any different method of examination.

We are, Sir,

Your obedient Servants,

WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

ON CADMIUM IODIDE.

By F. W. CLARKE and E. A. KEBLER.

OF late years the suggestion has repeatedly been made, by various chemists, that the definite series of related chemical elements may be analogous in character to series of compounds such as the hydrocarbons. For example, fluorine, chlorine, bromine, and iodine form one such series; the nitrogen group, from nitrogen to bismuth, forms another, &c. There have been many efforts to trace relationships between the atomic weights in these and other similar series, and so to get evidence in favour of the foregoing hypothesis; but except in the establishment of the periodic law, all such attempts seem to have ended fruitlessly.

But notwithstanding the failure to discover definite numerical relations between the elements, the evolutionary speculation is suggestive. If the series of elements are developed progressively, like series of compounds, there should be various points of comparison; and one line of thought is as follows. In any series of compounds the possibility of isomerism increases as we ascend; and therefore, by analogy, we should expect to find a similar state of affairs among the so-called elements. The derivatives of the highest member of a series should be more numerous and complex than those of lower members, and cases of allotropy or isomerism ought also to be more frequent. Whether this is so or not in all known instances we do not attempt to say; our experiments bear upon a single point, and that may be stated briefly.

It is a well-known fact that allotropy is common among the metallic iodides, and much more so than among the corresponding compounds of chlorine and bromine. For example, the scarlet and yellow modifications of mercuric iodide, and the three varieties of antimony iodide may be cited. We have been engaged in the study of several other iodides, especially that of cadmium, and in this case we are now prepared to announce the existence of two distinct modifications. So far, then, our results lend countenance to the speculative idea which we began by quoting, even though much weightier evidence would be needed to put it upon the basis of a clear and definite theory. The speculation, however, instigated our experiments, and in their success its utility as a means of stimulating research is justified.

Up to the present time but two determinations of the specific gravity of cadmium iodide have been published. First, by Bödeker, who found it to be 4.576 at 10°; and, second, by Fullerton, whose mean result was 5.9798. The latter determination was made some years ago in this laboratory, and is undoubtedly too high; but the discordance between the two is so great that it could hardly be ascribed to error. Accordingly, we prepared cadmium iodide by a variety of methods, and obtained the following determinations of specific gravity. All weighings were made in benzene, and the results are referred to water at 4° as unity. Our mean figures may be stated first, and the details given later.

A. Cadmium and iodine, in equivalent quantities, were heated together in a sealed tube from which the air had been exhausted. The product was white, and contained

1.30 per cent of residue insoluble in water. Its character was established by analysis, and we found it to contain about 98.5 per cent true CdI_2 . Sp. gr. 5.543.

B. Cadmium and iodine were digested together under water. The crystals obtained by evaporation were carefully identified as CdI_2 . Sp. gr. 5.622.

C. A very fine sample of iodide prepared by Schuchardt, of Goerlitz, was examined. Its mode of preparation, as stated in a letter from the maker, consisted in dissolving together equivalent quantities of cadmium sulphate and potassium iodide, evaporating to dryness, extracting with alcohol, and crystallising. Sp. gr. 5.660.

D. Preparations A and B were mixed and re-crystallised from alcohol. The sp. gr., as determined by Mr. E. Twitchell, was 5.701.

So far, at least, the variations in our results were not startling. Our next series came out differently.

E. Cadmium carbonate was dissolved in hydriodic acid. The solution, discoloured by free iodine, was rendered nearly colourless by cadmium clippings, and crystallised. Sp. gr. 4.612. A second series of determinations gave 4.596. Both figures agree well with Bödeker. The salt was analysed, with results as follows:—

	Found.	Calculated for CdI_2 .
Cadmium.. ..	30.40	30.60
Iodine	69.33	69.40
	99.73	100.00

F. To verify these results, if possible, another lot of iodide was prepared with carbonate and acid, but the solution was not decolourised by metal. Sp. gr. 5.729. The sample on analysis yielded 30.56 per cent of cadmium.

G. Another solution was prepared as under F, and divided into two parts. One was allowed to evaporate spontaneously at a low temperature. Sp. gr. of product 5.610.

H. The second part of solution G was boiled down rapidly. Sp. gr. of iodide 5.675.

I. Metallic cadmium was dissolved in hydriodic acid. The solution yielded a pure iodide of sp. gr. 4.688, as determined by Mr. Twitchell. This preparation dried at 50° became silver-grey, and its sp. gr. rose to 5.141. Again heated to 50°, the sp. gr. rose to 5.536. A third heating brought it up to 5.545. Accompanying this change there was a little decomposition, which resulted in the formation of a trifling amount of insoluble material.

The foregoing results all point pretty definitely to the existence of two allotropic varieties of cadmium iodide, differing in specific gravity by about a unit. The higher density represents a union of cadmium and iodine with little or no change of volume, while the lower corresponds to a noteworthy expansion and consequent instability. The higher or normal salt, which we may call α -cadmium iodide, is white, and undergoes no perceptible change when heated to any temperature below 250°. The lower, or β -salt, is brownish, and loses weight even at 40°. One sample lost 5.50 per cent at 50°, an alteration which is undoubtedly due to the formation of an oxide or oxy-iodide with liberation of iodine. The increase in specific gravity upon heating may be partly due to the same change, but is mainly ascribable to a transformation of the β into the α modification. The conditions governing the formation of the new salt are obscure and need further study. In our experiments we obtained it only twice, and in each case cadmium was acted upon by hydriodic acid. In the first instance, however, this action was only incidental to the decolourisation of a solution of iodide otherwise prepared, and was necessarily very trifling. In both cases, however, cadmium iodide was exposed to the action of nascent hydrogen, and it is probable the latter had something to do with the production of the β compound. This suggestion we offer merely as a clue for use in further study, without any speculations as to just how the reactions proceeded.

In detail, our specific gravity determinations were as follows, including the temperatures of weighing. The series are lettered as before:—

I. The Normal CdI_2 .

A.	B.	C.	D.
5.539 20.4°	5.622 15.2°	5.697 17.5°	5.716 14.8°
5.530 20.1	5.618 15.2	5.704 18.0	5.714 15.3
5.530 20.1	5.638 15.2	5.630 18.2	5.696 15.5
5.574 20.2	5.629 15.4	5.650 18.1	5.696 15.8
5.543 19.9	5.630 15.6	5.642 18.2	5.685 15.9
5.543 19.9	5.621 16.1	5.626 18.2	
5.523 19.8	5.610 16.6	5.672 18.2	
5.564 20.1	5.611 16.6		
5.543	5.622	5.660	5.701

F.	G.	H.
5.750 10.5°	5.580 17.6°	5.682 15.0°
5.740 10.5	5.610 17.4	5.654 15.2
5.715 10.6	5.660 17.7	5.683 15.1
5.747 10.5		5.682 15.0
5.719 10.6		
5.705 10.6.		
5.729	5.610	5.675

Total, 41 weighings. Mean of all, 5.644.

II. β CdI_2 .

E ₁ .	E ₂ .	I.
4.618 14.0°	4.598 15.2°	4.697 18.8°
4.607 14.4	4.594 15.3	4.713 18.9
4.609 14.7	4.601 15.2	4.740 19.0
4.618 15.0	4.602 15.2	4.668 19.0
4.612 15.1	4.592 15.4	4.625 18.9
4.615 15.1	4.593 15.4	
4.605 15.2	4.595 15.2	
4.612	4.596	4.688

Total, 19 weighings. Mean of all, 4.626.

Molecular volume α salt	.. ..	64.8
„ „ β „	.. ..	79.2

Mol. vol. $\text{Cd} + \text{I}_2$, 64.3, when sp. gr. iodine = 4.948 (Gay-Lussac), and sp. gr. Cd = 8.655 (Matthiessen).

In connection with these experiments a little work was done upon the double iodides of cadmium. Attempts were made to prepare such double salts with the iodides of lead and of thallium, but unsuccessfully. Mercuric iodide dissolved freely in a hot solution of cadmium iodide, and the liquid upon cooling deposited scarlet crystals of the first-named salt unaltered. The mother-liquor from these crystals, upon longer standing, yielded golden laminae, which were re-crystallisable from hot alcohol. They were anhydrous, and contained iodine, cadmium, and mercury. A partial analysis pointed to the formula $\text{CdI}_2 \cdot 3\text{HgI}_2$.

	Found.	Calculated.
Cadmium	6.90	6.48
Iodine	58.80	58.98
Mercury	34.30 (by diff.)	34.54
	100.00	100.00

There was not enough of this salt to admit of further investigation.

With other iodides we have not yet gone very far. Zinc iodide, prepared by direct union of the elements and sublimation in a stream of carbon dioxide, has a sp. gr. of 4.666.* Bödeker found a sp. gr. of 4.696. For a some-

* Value actually found, 4.736. This was corrected for 3.13 per cent of admixed metal, becoming 4.666. There were six concordant estimations.

what impure bismuth iodide from Schuchardt we found the sp. gr. to be 5.548. Bodeker's value was 5.652.

With stannic iodide we are still engaged. Suffice it to say that we are satisfied of the existence of at least two modifications, one darker red and less soluble in benzene than the other. But the difficulty of obtaining pure and definite products is very great, and we may not have time to complete the investigation. — *American Chemical Journal*, vol. v., No. 4.

ON THE
USE OF MERCURY THERMOMETERS,
WITH PARTICULAR REFERENCE TO THE
DETERMINATION OF
MELTING- AND BOILING-POINTS.

By J. M. CRAFTS.

(Continued from p. 289).

The Rise of the Zero-point.

AFTER a depression of the zero-point, if the thermometer is left at the ordinary temperature, the zero is found to gradually rise through a tendency to return to its original position,* and the study of such movements as may be produced by exposing a thermometer during a very long time to constant temperature gives the data for calculating the position of the zero-point under all circumstances, and what is more important, the study of this question leads to the discovery of the means for preventing those variations of the constants of a thermometric scale which are fatal to the precision of all measurements. It is particularly from this point of view that we are interested in the subject, and only those details will be given which have a direct bearing upon improvements in the manufacture of thermometers.

If after a depression produced by heating a thermometer is heated at a lower temperature, the zero-point tends to gradually return to the position which is normal for this last temperature. The complete return or rise of the zero is more rapid in proportion as the temperature which produced the depression is not far removed from that which brings about the rise. The time required for this movement is measured by hours at the highest temperatures and for small intervals (10° to 20°), and by days or months at lower temperatures (100° or the ordinary temperature). When the interval is very large a part of the depression produced at a high temperature is permanent at the lower temperature. Thus a thermometer heated at 355° may be left for an indefinite period at the ordinary temperature without showing a rise of the zero equal to more than one-half of the true depression, but this depression may be made to disappear entirely when the thermometer is heated methodically for several days at each of the temperatures 300° , 250° , 200° , and so forth, to the ordinary temperature.

When a new thermometer is heated during a week or ten days at 355° a very considerable rise of zero is noticed. In the case of soda glass the zero may rise 10° or 15° , and with crystal glass 15° to 26° . This movement is probably the return from a depressed position, like those which have been previously described, and it may be assumed

* I have followed this movement under varied conditions in order to ascertain if it is regular, *i.e.*, if the experiments can be so arranged as to give identical results under conditions which appear to be similar. In more than 1000 observations the divergences which escape a control of this sort do not appear to exceed 0.02° to 0.03° , but it would be very difficult to find a general formula for a movement which not only depends upon the time but also upon the temperature, and it must also be remembered that the depressions whose disappearance constitutes the phenomenon to be observed are often due to successive heatings at various temperatures, and represent the accumulation of several different impulses. Mr. Mills in a general formula for the rise of the zero-point at the ordinary temperature appears to have taken into account no factor except the time.

that the depression of the zero or the abnormal expansion of the glass was produced during the operation of blowing the bulb of the thermometer, and that it has resulted from the rapid cooling of the glass while still soft. Moreover, as it has been seen that the depressions of the zero-point produced at 355° or 300° persist at the ordinary temperature, so also this abnormal expansion produced at a red-heat is permanent at low temperatures. And it is in accordance with the rule derived from the previous results that the abnormal expansion should disappear when the thermometer is heated to a temperature nearer to that which produced the expansion. Thus the extraordinary rise of the zero-point which may be produced by heating to 355° or higher temperatures is probably almost entirely due to the same causes which induce the permanent elevation of the zero-point at the ordinary temperature, and the effects which previous observers have attributed to the pressure of the atmosphere are really due to an interior transformation* of the glass, almost or quite independent of external pressure. Thus similar results are obtained with vacuous or air-filled thermometers, and the progress of the changes, which have to do almost exclusively with the duration of time and the temperature to which a thermometer of a given kind of glass is exposed, is entirely under control.

Let us examine the rapidity of the change at different temperatures. The rise of the zero-point in a thermometer which is kept at the ordinary temperature becomes continually slower, and ceases to be appreciable after five or ten years. Thermometers have been observed for more than two centuries, and even after this great lapse of time the displacement of the zero is not more considerable. It usually attains about one-half a degree. In the same way the rise of the zero which is produced by heating to any fixed temperature tends to reach a limit, and the whole movement appears to be more rapidly completed the higher the temperature. On heating to 355° , after ten days, without having reached the limit, the thermometer may be considered as having become virtually stable, since the movement of the zero-point has become so slow that no noticeable displacement is produced during any ordinary experiments of short duration, even when the heat is carried as high as the boiling-point of mercury, and such a thermometer may be heated several days at 300° or 200° , or several months at 100° , or it may remain several years at the ordinary temperature without alteration to the effect produced at 355° . By this is meant that, although certain slight elevations take place at lower temperatures such as those which have been previously described, yet, whenever the thermometer is heated again to 355° , the zero-point immediately returns to the position which it had after the first prolonged heating in boiling mercury. It may be concluded from what precedes that the extreme variations of the zero-point to be observed with what has been called a stable thermometer, are comprised within limits of about 2° between the point of extreme depression for 355° , and a complete return to the higher position corresponding with the ordinary temperature, and the table of depressions gives the point within these limits to which the zero may be brought and permanently fixed by heating

* Dr. Löwenberg (*Berichte Chem. Gesell.*, x., 472) supposes that the particles of glass after heating are in a state of tension produced by the slight conductivity of glass, which occasions a cooling or setting in successive layers, and that this abnormal tension may disappear in consequence of oft-repeated molecular movements. I am unable to estimate the consequences which follow upon this manner of considering the phenomena, but the following experiment was suggested by M. Dufour's observations upon rapidly cooled glass drops. He found that these drops contain a vacuous cavity, and consequently that after the solidification of the outside layer the interior mass must solidify under a diminished tension. It occurred to me to examine whether the exterior layer of the bulb of a thermometer exercises mechanical pressure on the interior layers: the result was negative. A large thermometer, newly made, was left in hydrofluoric acid until about one-third of the thickness of the bulb was dissolved, and no considerable change in the position of the zero took place. Care was taken to open the stem before the experiment in order to guard against the effect of the pressure of the atmosphere upon the bulb, made thinner by the action of the hydrofluoric acid.

at any constant temperature.* Similar series of observations were made with exactly similar results when, instead of 355°, the highest limit of temperature was fixed at 300°, 260°, 200°, or 100°.

It will be seen that only thermometers that have thus been made stable can be used where the position of the zero is to be determined by calculation, and what is more important it is that only with such instruments is the value of the degree constant, and that with constant thermometers any table of corrections obtained by comparison with an air thermometer remains permanently applicable. It may be added that the curve of corrections for thermometers that have been so heated as to produce the largest displacement of their zero-point does not vary in form from the curves of corrections to be applied to new thermometers to bring their scale into accordance with that of a gas thermometer. Five of the thermometers which were used in my experiments to compare the mercury with the hydrogen thermometer were subjected to a prolonged treatment at high temperatures, and the curve of average corrections obtained with these five instruments was found not to differ essentially from the average corrections determined from the other thermometers.

The Preparation of Thermometers.

The conclusions to which the preceding paragraphs lead may be summed up in a few general directions for rendering thermometers unchangeable. Those which are intended for the ordinary experiments between zero and 360° should be heated throughout the whole length of their stem for a week or ten days in boiling mercury, and the graduation, the determination of 100° and zero-points, and the calibration, should be made after this treatment; they then acquire a permanent value. When the scale only extends to some lower temperature, 200° or 100°, the time required for the preliminary treatment is proportionally longer. To prepare a standard thermometer for use at temperatures between zero and 100° it should be heated throughout its length for several weeks at 100°, or the process may be shortened by heating it in essence of turpentine at about 156° for four days, and then for a week at 100°.

The thermometers must not in any case be subjected for a long time to the action of water, and all these operations can be most conveniently carried out with a metallic apparatus, which is similar to that described further on for fixing accurately certain temperatures, except that many of the precautions there recommended for avoiding slight variations may be omitted. A cylindrical vessel of copper or iron with an hermetically fitting cover communicates with the air by means of a tube, upon which is fixed a condenser, so that evaporation is prevented and the heating at a constant temperature may be prolonged for any length of time. The thermometers are placed in an interior tube closed at the bottom and fitted into the cover with a perfectly tight joint. All the joints are brazed when the apparatus is made of copper. They are fitted by grinding and sweating on when the apparatus is made of iron. These pieces of apparatus have been found most convenient for heating sealed tubes or for any laboratory work where a fixed temperature is required. By the use of several substances, boiling under varied pressures, any temperature can be maintained constant for days or months to within one-fifth degree. They require no attention to regulate temperature, they are quickly heated and cooled, and if the sides are properly protected by a non-conducting jacket they are much more economical of gas than any oil or air-bath used for similar purposes. This mode of maintaining fixed temperatures, which was first studied by Regnault, cannot be too highly recommended for laboratory work.

A tight-fitting apparatus for boiling mercury is difficult

* This statement must be taken in conjunction with what has been previously said concerning the persistency of depression for long intervals of temperature, and the appropriate means of making them disappear.

to construct, and when it is only to be used to prepare "constant" thermometers for graduation (but not to graduate them), it suffices to use an iron tube closed by welding at the bottom, 5 or 6 c.m. wide and 1 metre long, filled with mercury to a height of 5 c.m. This lower portion is heated directly over the lamp. A non-conducting jacket protects a length above this of 60 c.m., and the mercury condenses in the upper part of the tube, which is exposed to radiation. Or in case mercury fumes are to be feared, the upper end of the tube can be surrounded by a condenser. The thermometers are enclosed in a sealed glass tube. A similar form of apparatus has been found most convenient for boiling sulphur and other substances in Victor Meyer's vapour-density determination.

Corrections to be applied to the Results obtained with the Mercury Thermometer to bring them to the True Temperature as measured by a Hydrogen Thermometer.

Each mercury thermometer has its individual scale requiring somewhat different corrections, but since the publication of Regnault's memoirs it has been customary to distinguish two categories of thermometers according as the glass is crystal containing oxide of lead or is ordinary glass. The columns A and B in the table below contain the corrections of Regnault for crystal glass from the manufactory of Choisy-le-Roy, containing 34 per cent of oxide of lead, and for ordinary French glass.

Neither of these kinds of glass is now used to make thermometers. The crystal which is employed at Paris contains about 18 per cent of oxide of lead; the German soda glass is free from lead, but it is much more fusible than ordinary French glass, hence a revision of these tables has become necessary. The column C of the table was obtained by experiments with 14 crystal glass thermometers made at Paris, and with a soda glass thermometer made at Bonn. To use the table the number of degrees centigrade is read off on the mercury thermometer, the position of the zero is determined immediately afterward, and the correction if necessary is made for its displacement; then the corrections of the table, observing their signs + or -, are added to the numbers of degrees thus obtained, and give the temperature which would have been found by a hydrogen thermometer, supposing that the calibration and the interval 100° to zero of the mercury thermometer are exact.

Temperatures,—

	110	120	130	140	150	160°
A ..	-0.05	-0.12	-0.20	-0.29	-0.40	-0.52
B ..	+0.02	+0.05	+0.09	+0.15	+0.20	+0.26
C ..	+0.02	+0.04	+0.09	+0.16	+0.25	+0.33

Temperatures,—

	170	180	190	200	210	220°
A ..	-0.65	-0.80	-1.01	-1.25	-1.53	-1.82
B ..	+0.32	+0.37	+0.35	+0.30	+0.25	+0.20
C ..	+0.35	+0.34	+0.32	+0.27	+0.18	+0.08

Temperatures,—

	230	240	250	260	270	280°
A ..	-2.16	-2.55	-3.00	-3.44	-3.90	-4.48
B ..	+0.15	+0.10	-0.05	-0.20	-0.38	-0.52
C ..	-0.02	-0.14	-0.26	-0.39	-0.50	-0.63

Temperatures,—

	290	300	310	320	330°
A ..	-5.10	-5.72	-6.45	-7.25	-8.22
B ..	-0.80	-1.08	-1.45	-1.80	-2.40
C ..	-0.88	-1.21	-1.60	-2.03	-2.48

The immediate measures made with the thermometers referred to in the above table were corrected for errors of calibration and for errors in the value of the degree. This latter correction should always be made after determining the number of degrees corresponding with the interval 100° to zero, and the previous remarks upon the errors of calibration show how far it is necessary to take these into account in ordinary thermometric work. It will be seen

that the corrections of the column C do not differ greatly from those found by Regnault with ordinary French glass, but are widely different from those of the column A.*

In my experiments the curves which represent the corrections for each thermometer show greater departures from the mean curve C as the temperatures increase, but the greatest differences found were only 0.3° at 200° , 0.5° at 300° , and 0.8° at 330° . These figures represent the extreme errors which are probable on using the column C to correct results with thermometers made at Paris. The German thermometer was not among those which showed the greatest divergence, so that the column C may be considered as applicable to soda glass thermometers, but some experiments made with a number of German thermometers induce me to believe that their average corrections should be slightly lower than those of the column C.

(To be continued.)

PROCEEDINGS OF SOCIETIES

CHEMICAL SOCIETY.

Thursday, December 20, 1883.

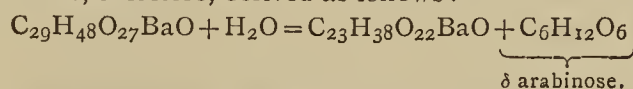
Dr. W. H. PERKIN, F.R.S., President, in the Chair.

THE following gentlemen were declared by the Scrutators, Messrs. Meldola and Williams, duly elected Fellows of the Society:—Messrs. W. P. Bloxam, A. Cobb, G. C. Chambers, A. E. Ekins, F. P. Haviland, F. Keeling, W. H. R. Kerry, J. J. Pilley, M. Percy, J. Phillips, A. W. Rogers, W. J. Saint, G. Smith, A. Smithells.

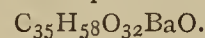
The following certificates were read for the first time:—J. H. Burland, R. A. Bush, T. R. Duggan, G. W. Gibson, F. W. Harris, C. W. Sutton, F. W. Tompson, E. W. Voelcker.

The PRESIDENT then called on Mr. C. O'SULLIVAN to read a paper entitled "*Researches on the Gums of the Arabin Group: Part I., Arabic Acid, its Composition, and the Products of its Decomposition.*" The author wishing to compare arabic acid with other bodies with which he was working, looked up the literature of the subject, but found the results obtained by previous observers so irreconcilable that he was forced to examine this substance for himself. The present paper contains the first results of this examination. The author has mainly followed the method employed by Neubauer. The gum is dissolved in the smallest possible quantity of water, and the solution decanted from any insoluble matter, twice or three times as much hydrochloric acid as is sufficient to convert the bases into chlorides is added, and the arabic acid then precipitated by an excess of alcohol. The curdy precipitate is washed with alcohol and pressed; it is then dissolved in boiling water, cooled, and alcohol gradually added with constant stirring. The liquid becomes milky, but no precipitate forms; a few drops of hydrochloric acid are added, when a curdy precipitate is produced. By the careful addition of hydrochloric acid the body can be precipitated in several successive portions. The author obtained four such precipitates, each portion was re-dissolved and re-precipitated several times, dehydrated with absolute alcohol, pressed, and dried over sulphuric acid. Thus treated the bodies are white, friable, soluble in water, and free from ash. By an optical examination and the analysis of their barium salts the author proved that he was dealing with a homogeneous body; the optical activities ranging from $[\alpha]_D^{25.7}$ to -27.0 , and the percentages of barium oxide from 5.90 to 6.07. It occurred to

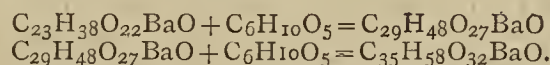
the author that a careful study of the action of sulphuric acid might throw some light on the nature and composition of arabic acid, and that this body should yield a sugar or sugars, and a series of acids of gradually diminishing molecular weight; in fact that it would behave after the manner of starch (*Chem. Soc. Journ.*, 1876, ii., 125). 500 grms. of arabic acid $[\alpha]_D^{27}$, which must be free from ash, were dissolved to 1500 c.c., and 40 grms. of sulphuric acid in 150 c.c. of water added. The mixture was boiled for three hours, cooled, and exactly neutralised with a hot solution of barium hydrate. The barium sulphate filtered off, the filtrate evaporated to 1000 c.c., and alcohol sp. gr. 0.83 added as long as a precipitate fell. This waxy precipitate was repeatedly dissolved in water, re-precipitated by alcohol to free it from sugar, and dried over sulphuric acid. This white friable body, when dried at 100° , gave 14.57 BaO. The arabic acid molecule had therefore broken up: it remained to be proved whether the substance was homogeneous or not. It was dissolved in water, and fractionally decomposed by successive additions of sulphuric acid into three portions, A, B, and C. A contained 14.27 per cent BaO; B, 14.35 per cent; C, 15.46 per cent. Portion C was further separated into three. The first contained 15.27 BaO; second, 15.36 per cent; third, 15.54 per cent. it was therefore fairly homogeneous. A and B were mixed, and on fractionation it became evident that there were two salts, one containing 13.3 to 13.4 per cent BaO, the other 15.5 per cent BaO. The author then studies the further action of sulphuric acid on this 15.5 per cent barium salt. 20 grms. were dissolved in water, and 2.5 c.c. of sulphuric acid previously diluted with water added. The mixture was digested for three hours at 100° . By neutralisation and treatment as above, a salt was obtained containing 18.5 per cent BaO. This salt was submitted to combustion; it gave numbers indicating the formula $C_{23}H_{38}O_{22}BaO$; it is, therefore, not a carbohydrate, but differs from the carbohydrate $C_{24}H_{40}O_{20}$ by the subtraction of CH_2 and addition of O_2 . The alcoholic solution from which this salt had been separated was freed from alcohol, the residue concentrated to a syrup, purified, and allowed to crystallise, when a sugar of the class $C_6H_{12}O_6$ separated out. Its optical activity was $[\alpha]_D^{79}$ to 81° , and copper reducing power $K=81$ to 82 . The salt containing 15.5 per cent BaO was next dried and analysed; it gave a formula $C_{29}H_{48}O_{27}BaO$. The 18.5 per cent BaO salt was doubtless, therefore, derived as follows:—



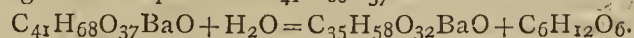
The 13.3 barium salt corresponds to the formula—



so that we have the series—



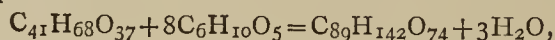
The high molecule being broken down with the elimination of $C_6H_{10}O_5$, which is hydrated to a sugar of the $C_6H_{12}O_6$ class: it appeared probable that the arabic acid molecule was broken down in the same way, and that its composition would be arrived at by adding such a multiple of $C_6H_{10}O_5$ to one of these barium salts as would give a compound containing the same quantity of BaO as barium arabate. To obtain further evidence of this disintegrating process, 200 grms. of pure arabic acid $[\alpha]_D^{27}$ were dissolved in 300 c.c. of water, to which 10 grms. of sulphuric acid were added, and the whole was digested at 100° for one hour. The product was separated as before by fractional precipitation, and eventually two salts obtained, containing 11.35 per cent BaO and 13.38 per cent BaO. The latter was the salt already noticed, $C_{35}H_{58}O_{32}BaO$. The 11.35 per cent salt was analysed, and gave a composition $C_{41}H_{68}O_{37}BaO$ —



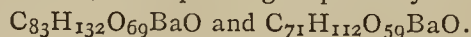
The free acid of this salt was also prepared; its analysis

* It is not probable that these differences are to be attributable entirely to the composition of the glass, and in a paper published in the *Comptes Rendus*, November 6, 1882, I have pointed out certain features of Regnault's method of operating which lead me to suppose that his corrections are too high.

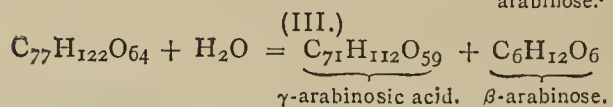
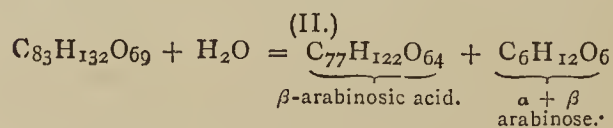
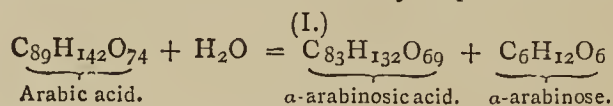
confirmed the above formula. At this point the author set to work to isolate the sugars which ought to be separated at the various steps of the disintegration of the molecule of arabic acid. Starting with the alcoholic solution from which the salt $C_{29}H_{40}O_{27}BaO$ had separated he succeeded in obtaining three sugars of the $C_6H_{12}O_6$ class, which he names β -arabinose, $\alpha_j = 111.1^\circ K = 110$; γ -arabinose, $\alpha_j = 91^\circ K = 99.4$ —to 100; and δ -arabinose $\alpha_j = 79^\circ$ to 81° , $K = 81$ —82; and in proving the presence of α -arabinose with a greater optical activity than β -arabinose. The author then gives the results of six analyses of arabic acid. The numbers lead to the empirical formula $C_6H_{10}O_5$. Now a barium salt containing C.H.O in this ratio, and at the same time 6 per cent BaO, should be $C_{90}H_{150}O_{75}BaO$; but such a constitution does not lead to the highest acid, $C_{41}H_{68}O_{37}$, obtained in the decomposition products. Thus $C_{41}H_{68}O_{37} + 8C_6H_{10}O_5 = C_{89}H_{142}O_{77}$; but writing the equation thus—



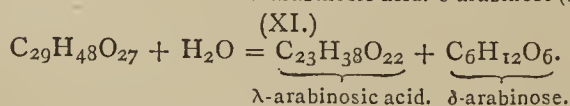
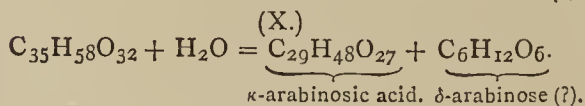
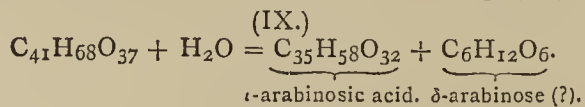
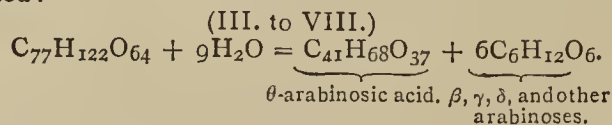
we obtain a formula for arabic acid $C_{89}H_{142}O_{74}$, which fits exactly with the combustion percentages, and requires 6 per cent BaO, the numbers obtained being 6.10, 5.90, 6.00, 6.06. The calcium salt was prepared, and gave similar results. Arabic acid may therefore be represented by $C_{89}H_{142}O_{74}$. Finally, the author made a successful attempt to isolate the acids intermediate between arabic acid and the $C_{41}H_{68}O_{37}$ acid. 60 grms of pure arabic acid were dissolved in 200 c.c. of water containing 4 grms. of sulphuric acid, and digested for fifteen minutes at $100^\circ C$. Two barium salts were obtained containing 6.45 p.c. BaO and 7.36 per cent, corresponding respectively to—



β -arabinose $\alpha_j = 111.5^\circ K = 110$ was also isolated, and evidence obtained that α -arabinose $\alpha_j = 140^\circ$ was present. Neither γ nor δ arabinose was detected. The author then gives a summary of this most important paper, respecting the decompositions of arabic acid by sulphuric acid.



The next five steps have not been followed, and so are united:—



This last arabinosic acid, $C_{23}H_{38}O_{22}$, is a very stable body, resisting the action of 3 per cent to 4 per cent solution of sulphuric acid for many hours. It probably splits up in a more complicated way than its predecessors. Arabic acid $\alpha_j = 27^\circ$ to 28° is the chief constituent of all the lævoptatory gums; other acids are present which bear a simple relation to it. In a future paper the author pro-

mises an account of dextro-rotatory and optically inactive gums, the acids of which are built up in the same manner as arabic acid.

Dr. ARMSTRONG said the paper was one of the utmost importance, and was the more interesting as it had been read by the chemist who first enlightened us as to the constitution of starch in 1876. He then contrasted the results of the present paper with those obtained in the case of starch, and pointed out the probability that starch has a very high molecular weight.

Dr. RAMSAY then read a paper entitled "*The Decomposition of Ammonia by Heat*," by W. RAMSAY and S. YOUNG. The results obtained may be summed up as follows:—When ammonia gas is passed through a porcelain tube, or an iron tube, or a glass tube, filled with asbestos card-board, the amount of decomposition at 500° to 520° is nearly equal and very small. Ammonia, therefore, begins to decompose a little below 500° . In contact with a glass surface the temperature at which decomposition begins is much higher; the amount of decomposition depends on the rate of passage of the gas and on the nature of the surface. Thus ammonia is completely decomposed by passage through a plain iron tube heated to 780° . By passing ammonia through a glass tube containing iron wire at 760° , 76 per cent of the ammonia was decomposed; with copper wire under similar conditions only 2 per cent was decomposed.

Mr. WARINGTON pointed out the importance of these results in connection with the now common practice of making soda-lime combustions in iron tubes.

Prof. FOSTER made some observations as to the bearing of these experiments on the quantity of ammonia obtained in the distillation of coal.

Dr. RAMSAY then read a paper "*On the Halogen Compounds of Selenium*," by F. P. EVANS and W. RAMSAY. The authors first prepared the selenium mono-chloride, Se_2Cl_2 , which splits on distillation into selenium and selenium tetra-chloride; the tetra-chloride is insoluble, the mono-chloride soluble in carbon disulphide. The selenium dichloride could not be prepared. Selenium tetra-chloride begins to decompose at 288° . The authors have also prepared selenium chloro-tribromide and the bromo-trichloride.

"*On the Preparation of Pure Chlorophyll*," by Dr. A. TSCHIRCH. The author states that chlorophyll is very unstable, being decomposed by acids and alkalis. He has prepared it by reducing chlorophyllan (*Botan. Zeitung*, 1882, 533) with zinc dust. The chlorophyll so obtained gives a spectrum identical with that given by living leaves.

The Society then adjourned to January 17th, 1884

NOTICES OF BOOKS.

Poisons; their Effects and Detection. A Manual for the Use of Analytical Chemists and Experts, with an Introductory Essay on the Growth of Modern Toxicology. By ALEXANDER WYNTER BLYTH, M.R.C.S., F.C.S., &c. London: C. Griffin and Co.

WE have here a sound, practical, and thorough-going manual of toxicology, and of something more. The author does not merely expound the most approved methods for the detection of poisons, whether in a separate state or in mixtures of organic matter. He describes their physical and chemical properties, the symptoms which they produce when conveyed into the human and animal system, the purposes to which they are applied in the arts, and the channels through which they may be introduced into articles of food, &c. There is also a brief abstract of the British, German, and French law on poisoning, and under several heads we find notices of the possible lines of defence which may be set up in criminal proceedings. The work, as will doubtless be remembered,

formed in its original state a part of the author's "Practical Chemistry." The great importance and the special character of the subject have necessitated its appearance, greatly enlarged and indeed re-written as an independent work.

The book begins with a very interesting historical introduction. We have here the poison-law of the Egyptians, Greeks, Hebrews, the Eastern Nations, of Rome under the empire, of the middle ages, and of modern Europe.

Here figure naturally the professional poisoners of Italy in the seventeenth century, among whom figure John of Ragubo, and the far-famed Toffana, whose "water," the Aqua Toffana, or *Acquetta di Napoli*, was widely dreaded. A little later flourished A. Croix and his paramour, the infamous Madame de Brinvilliers, who seems to have occasionally poisoned inoffensive persons as a matter of experiment.

In the next section, which describes the progress of modern toxicology, we have an account of the researches in the direction of Scheele, Proust, Serullas, and Marsh. This last chemist, it is said, was not the original discoverer of the test which bears his name. He merely perfected the process and brought it into general notice. The true father of toxicology as now practised was M. J. B. Orfila. To him is due the capital discovery that poisons when taken become absorbed and localised in certain organs, which it is accordingly necessary to examine. Previously, the chemist, if unable to detect poison in the contents of the stomach, or in vomited matter, did not trouble himself with the brain, the liver, the blood, &c., and so the substance in question might often escape detection.

We then come to the definition of poison, both from a legal and a scientific point of view. The English law holds a poison to be any destructive thing administered to and taken by a person. Hence, as the author shows, the legal notion of poison would include, in addition to substances which act in virtue of their chemical nature, "boiling water, molten lead, specifically infected fluids, the flesh of animals dying of diseases which may be communicable to man, powdered glass, diamond dust, &c." The law also, as now existing, covers the introduction of noxious matter into the body, not merely by the mouth, but by any and every possible channel. The laws of Germany and of France take, substantially, the same ground.

The scientific definition of poison is, however, totally different; it must exclude substances which injure mechanically, like powdered glass; physically, by their high temperature or by their physiological character. This author proposes the following definition:—"A substance of definite chemical composition, whether mineral or organic, may be called a poison if it is capable of being taken into any living organism, and causes, by its own inherent chemical nature, impairment or destruction of function."

In explanation it must be noted that Mr. Blyth considers the poisonous secretions of animals and vegetables as containing some definite chemical compound, or a mixture of several such compounds upon which their efficacy depends.

Such bodies consequently do not possess the power of reproduction and cannot multiply in the remains of the animal destroyed. Further—an important practical conclusion—they cannot be combatted by agents of the anti-septic class, such as phenol, salicylic acid, &c.

The author's classification of the poisons is of a purely practical nature, being based upon the procedures to be used in their detection. On this principle he places firstly the stronger acids and alkalies; next follow volatile poisons capable of being separated by distillation from neutral or acid liquids; thirdly, alkaloids and poisonous vegetable principles separable for the most part by alcoholic solvents; fourthly, poisons derived from living or dead animal substances; and lastly, the inorganic compounds.

It will be found on an examination of this book that the number of poisons is far greater than is commonly supposed. As most of these substances have abundant uses

in the industrial arts perfectly independent of their effects upon the animal organism, the impolicy, not to say the impossibility, of sweeping restrictions upon their sale is obvious. We are sorry to find that not a few medical men and pharmacists continue to agitate in this direction. Nor must it be overlooked that certain principles, *i.e.* vegetable acids, which occur in ordinary articles of human food, are quite capable of proving fatal if taken in sufficient doses. It seems to us grossly inconsistent to propose prohibitive regulations for the disposal of the mineral acids and yet tolerate the common sale of ammunition and explosives—articles far more dangerous to the public and far less generally useful in civil life.

One of the chief merits of Mr. Blyth's book is that it discusses certain substances which have been overlooked in many manuals of toxicology.

Thus, chromium and its compounds are here, for the first time, we believe, in any English work, considered in some detail. That they should hitherto have been overlooked is strange in view of the fact that it is a powerful irritant, and that it is used in the Arts on a very large scale, finding its way by the waste waters of dye-works into the streams. What are its effects upon vegetable life, and whether, if so, to what extent it is capable of being absorbed by plants, it has not been ascertained. Mention is here made of the chronic poisoning sometimes experienced by workmen at the manufactories of the bichromate. The principal feature here is destruction of the septum of the nose. It is said, though the author does not vouch for the accuracy of the statement, that "when a man has thus lost his nasal septum he no longer suffers from nasal irritation, and has a remarkable immunity from catarrh."

The hands of the workmen engaged in dyeing chrome blacks, on woollens and worsteds, and still more those who dye chrome yellows and oranges on cottons, are often severely ulcerated. The mischief may extend, it is said, to the entire destruction of the fingers. We never, however, obtained complete evidence of such a case, and in all well managed dye-works, a man who is found specially amenable to the poison is at once removed to some other department of the business.

Another, little known, though very common and deadly substance, is barium in its soluble compounds. It is also procurable in certain districts without the risk of purchase. There are parts, both in England and Scotland, where the native barium carbonate, witherite, may be picked up by the road-side.

Among better known substances arsenic, which may almost be considered as our national poison, is treated of at great length. First, we find the question of the solubility of arsenious acid—a point of some importance in Madeline Smith's case. By boiling, water may be made to retain 2·01 to 3·3 per cent of the anhydride. What influence, if any, the presence of different kinds of organic matter may have upon its solubility, the author does not attempt to decide.

The effects of arsine appear to be very variable. Nine workmen were poisoned more or less severely in consequence of inhaling the fumes given off on treating arseniferous silver lead with hydrochloric acid,—an operation which should have been performed under a very powerful draft-hood. Three of the patients died and the others recovered after several months' illness.

The action of arsenic by plants and its possible assimilation meets with due notice. The results obtained by different chemists are not accordant, and there is hence scope for further research. E. Davy, Tuson, and Andonard maintain that plants may take up arsenic if manured with superphosphate which has been prepared with arseniferous sulphuric acid. On the other hand, Gorup-Besanez maintains that if arsenious acid be mixed with earth, plants growing in such soil take up only infinitesimal quantities of the poison. It is fully established that plants die if their root or stem be placed in aqueous

solution of arsenic. But it is still an open question whether they may not gradually, like certain animals, be brought to tolerate this substance if applied in minute proportions. This matter deserves the most careful investigation, as food-plants are now brought in contact, not merely with possibly arseniferous superphosphate, but with copper arsenites (Paris green) used to kill destructive insects.

The existence of the practice of arsenic-eating, which was at one time contemptuously denied, is now placed beyond all doubt. This fact, like the possible, if not probable, occurrence of arsenic in vegetable matter, may, in a case of poisoning, suggest lines of defence which the expert will do well to take into consideration. As the author also points out, the inhalation of the fumes from arsenical candles or emanations from wall papers, &c., and, in the case of an exhumed body, the possible entrance of arsenic into the corpse from the soil of the cemetery, may also be brought forward to account for the presence of the poison.

As regards cantharides, an interesting fact is made known. Upon fowls, turkeys, and frogs these beetles have no action. Yet, persons subsequently eating the flesh of such animals may be seriously affected. Thus, French military surgeons, in Algeria, occasionally meet with inflammation of the bladder among the soldiers. This is "caused by eating frogs in the months of May and June; the frogs living in those months almost exclusively upon a kind of cantharides."

The ptomaines and the poisons of snakes are discussed with great ability. Into these subjects space does not allow us to enter further than by mentioning that Dr. Shortt, and subsequently the author himself, had anticipated the researches of Dr. Lacerda on snake-poisons. His alleged remedy, potassium permanganate, though it destroys the poisons if mixed with them in a concentrated form, has no antidotal powers when injected into the human body.

In conclusion, we must pronounce Mr. Blyth's work as one which cannot be too warmly recommended to medical practitioners and chemical analysts who may come in professional contact with poisoning cases.

CORRESPONDENCE.

DETECTION OF ALBUMEN IN URINE.

To the Editor of the Chemical News.

SIR,—In the CHEMICAL NEWS, vol. xlvii., p. 239, there appears "A New Test for Detecting Albumen in Urine." Considering that phosphates, in one form or another, are always present in urine, I fail to see the value of the test. The acetic acid which the author adds certainly cannot prevent the precipitation of iron phosphate. If I may, I should like to ask what his further experience on this point has been.—I am, &c.,

W. P. MASON.

Winslow Laboratory,
Rensselaer Polytechnic Institute,
Troy, N.Y., Dec. 7, 1883.

NEW ACID IN TOBACCO LEAF.

To the Editor of the Chemical News.

SIR,—Please insert following note in your next issue as claim to priority :—

The writer has been engaged for some time in the study of an acid present in tobacco leaf, which bears the closest resemblance to caffetannic acid, and also to pyrocatechol. It is combined in the leaf with some base, perhaps nicotine. Its further study is being continued.—I am, &c.,

T. J. SAVERY.

Royal Agricultural Society's Laboratory,
12, Hanover-square, Dec. 21, 1883.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin,
Vol. 16, No. 6.

Hydroxylamine Reactions.—V. Meyer.—A. Müller has examined the action of hydroxylamine upon phenylglyoxylic acid and other ketonic acids. Lævulic acid yields a finely crystalline iso-nitroso-valerianic acid. Mesoxalic acid, benzoyl-cyanide, and glyoxalic acid react easily and yield characteristic products.

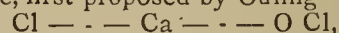
On the Aldoximes.—J. Petraczek.—An account of benzaldoxime, its behaviour with hydrochloric acid and sodium salt of benzaldoxime and its reactions with solutions of the heavy metals. The author describes the methyl-ether of benzaldoxime, the decomposition of methylbenzaldoxime by acids, methyl-hydroxylamine hydrochlorate, the ethyl-ether of benzaldoxime, its propyl-, isobutyl-, and allyl-ethers and iso-amyl-aldoxime.

On Diethyl-acetacetic Acid.—M. Ceresole.—An account of this acid and of its barium salt.

Ethers of Iso-nitroso-acetone.—M. Ceresole.—The author describes the methyl and ethyl-ethers of iso-nitroso-acetone, the methyl ether of iso-nitroso-methyl-acetone, the benzyl ether of benzyl-iso-nitroso-acetone, and adds remarks on the formation of the salts of the iso-nitroso-ketones.

Formation of Acetol from Sugar.—A. Emmerling and G. Loges.—The authors obtain acetol both from grape-sugar and cane-sugar, and finds both identical with each other and with the alcohol of acetone.

On Chloride of Lime and Analogous Bodies.—G. Lunge and P. Naef.—The authors infer from their experiments that the bleaching-compounds obtained from the bivalent metals, calcium, strontium, and probably barium, have in all probability the nature of double salts of the formula $\text{Cl} \dots \text{R} \dots \text{O Cl}$, in which all the chlorine can be directly replaced by carbonic acid. The formula for chloride of lime, first proposed by Odling—



must be still retained, as all Kraut's objections against it have been completely refuted.

Schizomycetic Fermentation.—Albert Fitz.—In the schizomycetes as well as in *Bacillus butylicus* the power of setting up fermentations is signally enfeebled by culture at high temperatures and with abundant access of oxygen.

On Dinitro-cinnamic Acid.—P. Friedlaender and J. Mähly.—The authors prove that a compound which they have described in former communications is dinitro-cinnamic acid by its reduction to a diamido-hydro-cinnamic acid. They describe para-nitro-benzaldehyd, dinitro-cinnamic ether, dinitro-cinnamic acid, dinitro-styrol, dinitro-phenyl- β -ethoxy-propionic ether and diamido-hydro-cinnamic acid.

On α -Mono-chloro-cinnamic Acid.—C. Forrer.—The author's mono-chloro-cinnamic acid is identical with that of Jutz.

Ethers of Phthalic Acid.—C. Graebe.—The author considers it probable that there exist two series of the ethers of phthalic acid.

Compound Isomeric with Euxanthone.—C. Graebe.—The author has obtained this isomer in an attempt to prepare euxanthone synthetically. He purposes continuing his researches.

Joint Oxidation of Aromatic Diamines and Monamines; a contribution to the Knowledge of the Saffranines.—R. Bindschedler.—The author discusses

here the oxidation products of dimethyl-para-phenylen-diamine and dimethyl-aniline; of the first-mentioned compound with dimethyl-aniline and aniline, with aniline alone and of para-phenylen-diamine and aniline. The details will be given in the *Annalen der Chemie*.

Contribution to the Quantitative Analysis of Chocolate.—R. Bensemann.—The author contends that the determination of fatty matter and theobromine in a chocolate is no certain guide to the quantity of cacao present. He proposes to determine the percentage of organic matter insoluble in water, of fat, and of starch. He gives the composition of several chocolates in which the cacao ranges down to 12.6 per cent, whilst the farina mounts up to 31.5.

Nitro-derivatives of Resorcin.—C. Schiaparelli and M. Abelli.—The authors effect the separation of styphnic acid from dinitro-resorcin by means of repeated crystallisation from alcohol.

Structure of the Hydroxylamine Derivatives.—W. Lossen.—This memoir does not admit of useful abstraction.

Salts of Ethylen-diquinoid and Methylen-diquinoid.—O. Rhoissopoulos.—An account of ethylen-diquinoid hydrochlorate, the corresponding hydrobromate, and hydriodate.

Action of Chloral upon Chinoline.—O. Rhoissopoulos.—On mixing the two liquids there is formed a white, butter-like mass, insoluble in almost all solvents. On treatment with strong hydrochloric acid there is obtained a white compound consisting of minute crystalline leaflets.

Compounds of Chinoline with Phenols.—K. Hock.—The author has obtained a compound of 2 mols. chinoline with 1 mol. resorcin. It is sparingly soluble in cold water, but readily in alcohol, ether, and chloroform. On prolonged boiling in water it is decomposed, chinoline being volatilised, whilst resorcin passes into solution.

Chloro-camphor and Nitro-chloro-camphor.—R. Schiff and J. Puliti.—The authors have obtained the same compounds of chlorine and camphor as those described in the *Comptes Rendus* by Cazeneuve, but by a different process.

Ammonium-Derivatives of Benzil and on the Formula of Benzil.—Th. Zincke.—M. Hænius, under the direction of the author, has studied the reactions of ammonia and the amines with benzil. The amines gave no reactions. The behaviour of ammonia with benzil had been previously studied by Laurent, who obtained three derivatives, imabenzil, benzilimide, and benzilam. According to Hænius these bodies really exist, but their composition differs from that assumed by Laurent.

On Chloro-naphtho-quinon-nitroso-anilide and on Oxy-naphtho-quinon-anilide.—A. Plagemann.—This paper is not adapted for useful abridgment.

Oxy-thymo-quinone from the dimethyl-amine-compound of Thymo-quinone.—H. Schulz.—Oxy-thymo-quinone crystallises from hot water or hot dilute alcohol in small, yellow, or brownish yellow needles. It is also soluble in ether, chloroform, and benzol. Its salts are not very characteristic.

Action of Strong Sulphuric Acid upon α -Nitro-anthraquinon-sulphonic Acid.—A. Claus and H. Engelsing.—By this reaction two hydroxyl-groups are introduced and the nitro- is at the same time reduced to the amido-group.

On Certain Derivatives of Anthraquinon- α -Disulphonic acid.—A. Claus and E. Schneider.—The anthraquinon-disulphonic acids can be readily nitrised in the same manner as the corresponding mono-acid. If lead anthraquinon- α -disulphonate, suspended in water, is treated with sulphuretted hydrogen, an intense green solution is obtained, which if evaporated in an atmosphere

of hydrogen leaves a residue of the same colour. If the green liquid is mixed with caustic potassa the colour turns to a deep red.

Behaviour of Para-brom-aniline with Sodium and Sodium-Propyl-bromide in Ethereal Solution.—A. Claus and A. Rogues.—The author's experiments prove that under the above mentioned circumstances there is produced a secondary propyl-aniline. In the moment when the sodium removes the bromine from the bromaniline, immediately, and before the propyl-residue which is disposable has time, an amido-hydrogen atom takes the place of the eliminated atom of bromine on the bromine nucleus, and then secondarily a propyl-residue attaches itself to the nitrogen in the place of the hydrogen.

Action of Sodium and Methyl Iodide upon Meta-brom-para-toluidine, Acet-meta-brom-para-toluide, and Dimethyl-para-brom-phenylamine in Ethereal Solution.—A. Claus and A. Steinberg.—Not suitable for abstraction.

Formaldehyd and Oxy-methylene.—B. Tollens.—The preparation of pure formaldehyd, or rather of oxy-methylene, must be effected at the lowest possible temperature, and with liquids previously concentrated as much as possible.

Behaviour of Dextrose with an Ammoniacal Solution of Silver.—B. Tollens.—One mol. dextrose precipitates 12 or 13 atoms of silver and takes up 6 atoms of oxygen. Much formic acid is produced in the reaction. Oxalic acid is also obtained. Glycolic acid has not been sought for. The author considers that dextrose cannot be regarded as an aldehyd.

Action of Dichloroacetic Acid upon Aromatic Substituted Amines.—Paul J. Meyer.—The author examines the action of dichloroacetic acid upon orthotoluidine, the result being diortho-toluido-acetic acid. With paratoluidine the result is an imesatine, containing in its nucleus an additional methyl-group.

Quinovic and Quinovaic Acid.—C. Liebermann and F. Geisel.—A very full account of α and β quinovic and of quinovaic acid. The authors remark that the by-products found along with the main constituents of plants are often of especial interest because they often bear to each other the same relations as do the main and the main and the secondary products of a chemical reaction.

Reduction of Nitro-toluol and Nitro-benzol.—H. Klinger.—An examination of a red, amorphous, indifefent substance, obtained by the action of sodium methylate upon para-nitro-toluol, and which the author regards as a tolylen-azoxy-tolyl.

Cosmos les Mondes.

No. 11, November 10, 1883.

This issue contains no chemical matter.

MISCELLANEOUS.

Royal Institution.—Mr. H. H. Johnston will give a discourse on "Kilima-Njaro, the Snow-clad Mountain of Equatorial Africa," on Friday Evening, January 25th: Professor Bonney's discourse on "The Building of the Alps," announced on that evening, will be given on April 4.

MEETINGS FOR THE WEEK

MONDAY, Dec. 31st.—London Institution, 5.
TUESDAY, Jan. 1.—Royal Institution, 3. "Alchemy," by Prof. Dewar.
THURSDAY, 3rd.—London Institution, 7.
— Royal Institution, 3 p.m. "Alchemy," by Prof. Dewar.
FRIDAY, 4th.—Pathological, 8.30. (Anniversary.)
— Geologists' Association, 8.
SATURDAY, 5th.—Royal Institution, 3. "Alchemy," by Prof. Dewar.

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